POWER

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The Broader Interest

TWO commuters were discussing the help-the-poor-railroad articles with which the public was being served.

"Well," said one, "They get twice as much out of me for the commutation ticket as they used to, But That's All! Otherwise, for the wife the bus, and for the vacation the little old buzz wagon."

In a restaurant a young householder, not unconscious or secretive of the fact that he was beginning to prosper, winds up an account of his recent installation of an oil-burning system in his residence with a forceful intimation as to where the coal people, producers, strikers, middlemen and retailers could go to so far as he was concerned.

Neither of these realized that the price of his commutation ticket and of the few tons of coal that he burned in his furnace and kitchen range was not by any means all that he was paying for railroad transportation and coal.

In fact, coal is no unimportant item in making up the prices that he pays for transportation; and transportation is one of the largest items that go into the price of delivered coal.

And into the price of practically everything that he buys enters the cost of coal and power for its manufacture and of its transportation to his door.

The total freight bill of the United States for the year 1925 was nearly $4,400,000,000, or 44 dollars for each man, woman and child in the country.

The total coal bill of the country for last year was over $2,700,000,000, or nearly 25 dollars per unit of the population.

Multiply these figures by the number of individuals in your family or household, the number of people that you are supporting, and you will get an idea of what your share of the fuel and railroad bill of the country would be if your consumption of the things in the manufacture of which coal is burned and which the railroad brings to your dealer would amount to if you were an average consumer.

F. R. Low

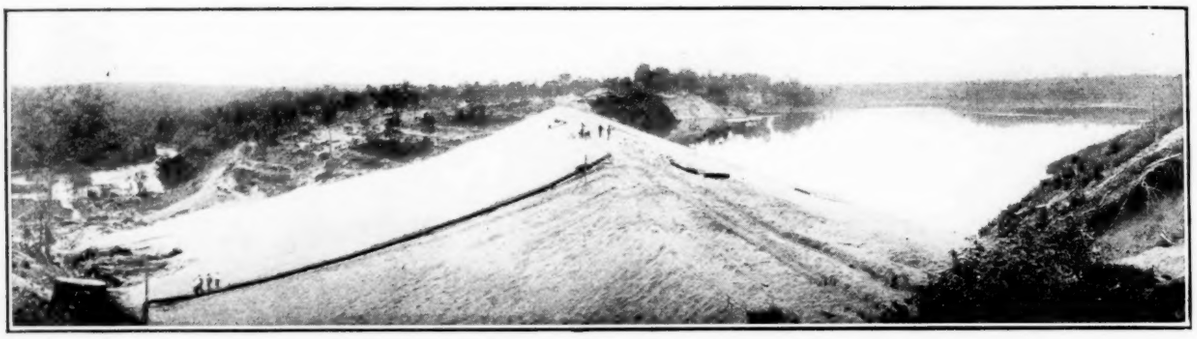


Fig. 1—Terminal dam which forms the forebay for the plant

Automatic Hydro-Electric Plant Designed for Peak Load Service

By GARDNER C. GEORGE
Designing Engineer, Northern New York Utilities, Incorporated

INSTALLATION designed for three 10,500-hp. turbines, two of which have been installed to operate under a 121.5-ft. head—Units are started and stopped automatically by closing or opening an oil switch at another station 4½ miles distant.

AUTOMATIC hydro-electric stations have become an important factor in water-power development, and this is well demonstrated in the Soft Maple plant of the Northern New York Utilities, Inc. This development is on the Beaver River, a tributary of the Black River, and is about 40 miles from Watertown, N. Y. (See Fig. 2.) The project includes one of the largest dams in eastern United States built by the hydraulic fill method and the largest remotely controlled hydro-electric station in the world. Work on the construction was begun in April, 1924, and the plant was successfully put in operation in September last year. As indicated in Fig. 3, the development includes five earth dikes, a concrete spillway, a diversion dam of earthwork to divert the Beaver River through the diversion canal into a natural storage basin formed by Beaver Meadow Creek, where the waters are impounded by the terminal dam and are thence led through an intake canal, a concrete headworks and short twin steel penstocks to the power house on the shore of Effley Pond.

This plant was built to carry the peak loads of the Power Corporation of New York system, of which the Northern New York Utilities, Inc., is the chief subsidiary. The system is located in the northern New York State, the portion between the Adirondacks and Lake Ontario and sells electric energy to public-utility and large industrial companies, besides serving directly with electric light and power the cities of Watertown and Rome and seventy-six other communities. It operates 26 hydro-electric, 5 hydro-mechanical and 2 steam plants.

This development forms an important link in the chain of plants on the Beaver River. The system now operates seven plants below Stillwater Reservoir so constructed that the total head is utilized between the headwater of the first and the tailwater of the seventh.

The difficulties in transportation led to the selection of the hydraulic-fill method of constructing the dams, as any other method would require many units of heavy equipment, all difficult to transport in comparison with lengths of pipe, pumps and motors.

Beaver River has a total length of 49 miles and drains a rough mountainous country which supports a dense

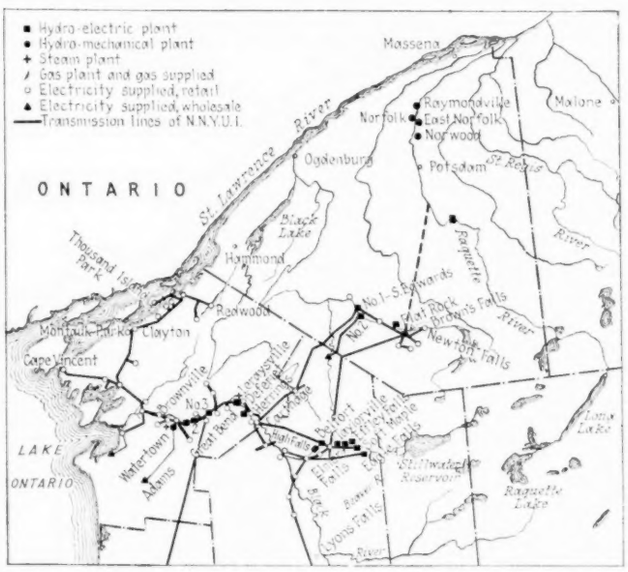


Fig. 2—Map showing part of the power system and location of Soft Maple plant

growth of hard and soft timber having an area of 338 square miles. There is a little fall above Stillwater, but between Stillwater and Beaver Falls the average grade is 33.4 per mile and the fall is 934 ft., of which the company has developed 610 ft.

Notwithstanding the regulating effect of the natural lakes and swamps and the artificial reservoirs on this and other tributaries, the lower reaches of the Black

River, of which the Beaver is a tributary, are subject to relatively high spring floods and low water in the summer. As a first step toward regulation, the Black River Regulating Board in 1924 enlarged the Stillwater Reservoir. The old reservoir covered an area of about 2,700 acres and had a capacity of 900 million cubic feet. The new reservoir has an area of 6,700 acres and a capacity of 4.5 billion cubic feet. This reservoir provides a minimum flow at Soft Maple of 383 cu.ft. per sec.

There were three ways this development could have been made. The first contained (See Fig. 3) dikes three, four and six, a dam located at the site of the present diversion dam, a pipe line 3,500 ft. long (shown by dotted lines) to a surge tank, and a short penstock to a power house on the bank of the Beaver River. The second scheme was the one adopted and is shown in the figure. The third scheme contained a large earth dam across the Beaver River just below the outlet of Beaver Meadow Creek, extending from *A* to *B* in the figure; a power house just below the dam; a spillway discharging into a vertical shaft and thence through a horizontal tunnel into Effley Pond.

Studies of the feasibility of this project for the three schemes outlined were made, assuming various load factors could be used in the operation of this plant. For all low load factors the second scheme proved to be most economical. From an analysis of the load curve for the entire system, to obtain the maximum output for the system it showed a peak-load plant was desirable. For the two units now installed the load factor is 22 per cent and with the installation of the third unit the load factor will be 14.7 per cent. This development is ideally located for a peak-load plant, since it has two ponds with a total area of 470 acres to draw from and will discharge into Effley Pond of 320 acres. The capacity of the two ponds above the power house at maximum draw-down is approximately 80 million cubic feet, which is also the capacity of Effley Pond. The entire head available between Eagle Falls plant just above Soft Maple and Effley Falls below could not have been utilized in the first scheme without an uneconomical expenditure for excavating a long tailrace in rock or lengthening the pipe line.

The two ponds forming the forebay of the plant are held back not by a single dam, but by a series of hills and ridges and nine structures virtually forming a composite and artificial dam about one and a half miles long. Between these series of hills where the depressions were slight, five earth dikes were built. Dikes 1 and 3 have a 6-in. Wakefield sheet piling to elevation 1,294 in the center. The three other dikes being smaller, the sheet piling was omitted. As a precaution against the larger dams being overtopped by flood beyond any expectations, dikes 4 and 6 were built to elevation 2.5 ft. lower than the other structures. The diversion dam as built is 900 ft. long and has a maximum height of 80 ft. The flow of the river during construction was passed by a circular conduit which rests on rock built on the west bank of the river. There is a gate tower (see insert Fig. 3) with a butterfly valve for drawing the pond down and for passing water to the plants below while the ponds were filling.

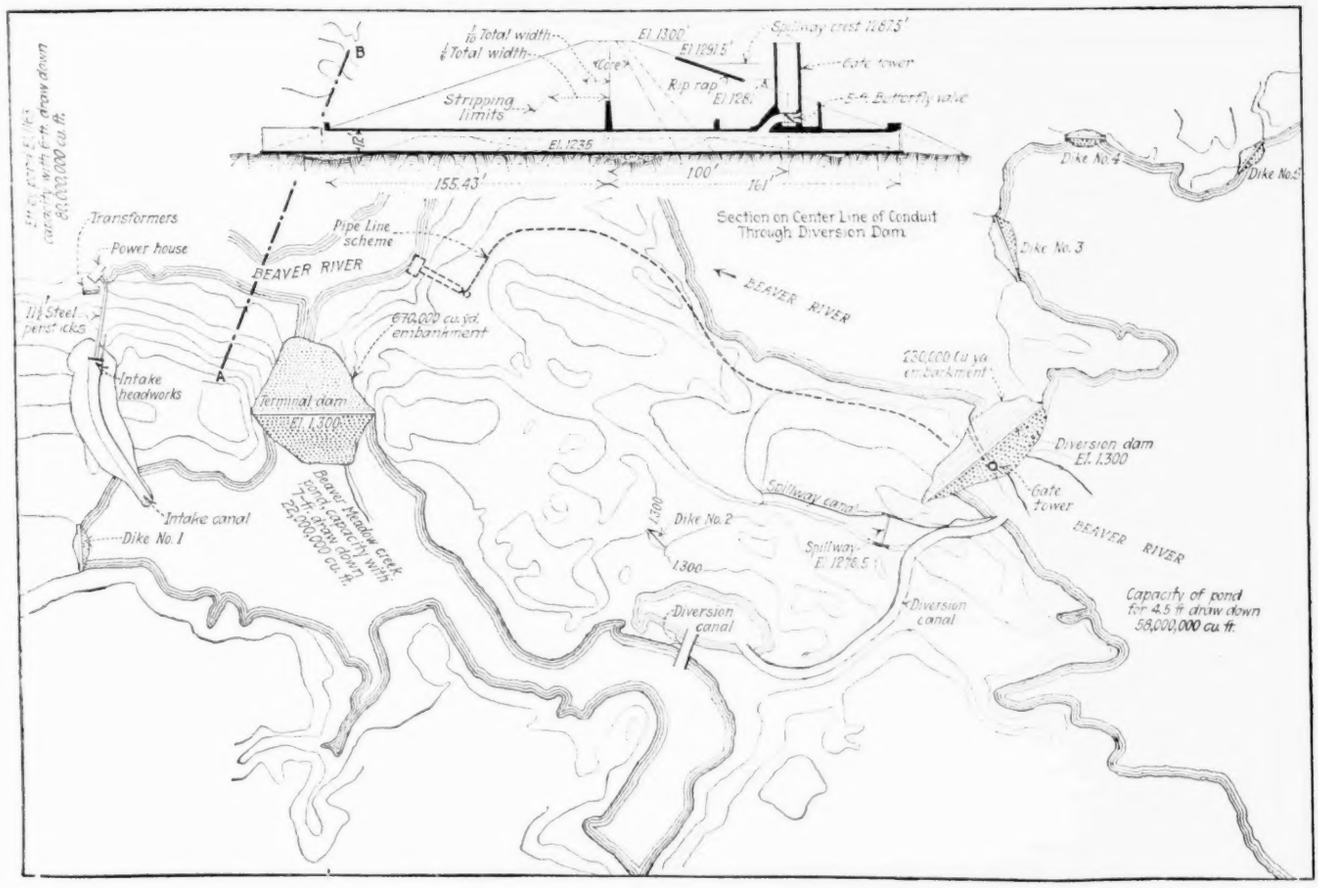


Fig. 3—General plan of the project and cross-section through diversion dam

This dam was built by the hydraulic fill method, the lower portions being sluiced into place and the upper dredge pumped. The coarser sand and gravel was deposited on the outer edges and the finer materials flowed into the central pool, forming a puddled core. The sluicing operations for this dam were similar to those for the terminal dam, which are described later.

All flood control is at the diversion dam, where the first 500 ft. of the spillway channel serves also as the diversion canal. The spillway is built on rock and will discharge 8,800 cu.ft. of water per second with the ponds at an elevation of 1,294. At maximum draw-down, 2,570 cu.ft. per sec., the full plant discharge for three units at minimum head, will flow through the canal with a difference of 2.5 ft. in elevation between the surfaces of the two ponds.

Beaver Meadow Creek pond is formed by the terminal dam, Figs. 1 and 3, a hydraulic fill between two sand hills at the north end of the valley. This dam has a crest length of 720 ft. with a 25-ft. top width and a maximum depth of 124 ft. The construction of this dam is one of the outstanding features of the development. A pumphouse erected on the bank of the Beaver River just above Beaver Meadow Creek had an installation of six suction and six booster pumps, each operated by 200-hp. motors. There was a valve arrangement such that any two or more pumps could deliver water right or left. Clear water lines of wood-stave pipe 24 in. in diameter ran from the pumphouse to the giants in the borrow pits. The material, being sand with some gravel, broke down easily and was sluiced through a steel pipe 20 in. in diameter to the dam. With a grade of 4 per cent no trouble was experienced in keeping the pipes clear. Considerable care was taken to keep the grade true without valleys. The stream carried 6 to 9 per cent solids. The gravel and coarser sand was deposited on the beaches forming the porous toes of the dam. The finer sand was carried into the central pool and settled to the bottom in the still water, forming a puddled core.

West of the terminal dam lies the intake canal (see Fig. 3). It was dug in fine sand and is unlined. The excavation was used in the terminal dam. Thus it was economically possible to make the section large and keep the velocities in the canal low to prevent cutting the slopes. With a maximum draw-down of 7 ft. below the crest of the spillway and with three turbines running, the maximum velocity in the canal will be 1.95 ft. per sec. It is not anticipated that the water at this velocity will carry the sand.

The intake, Figs. 4 and 5, a concrete structure, is founded in the sand of the plateau, as borings did not indicate rock within economical reach. After the sand had been excavated to grade one row of 6-in. Wakefield sheet wood piles was driven as a cutoff to a depth of 20 ft. below the bottom of the base slab. On each end, where the concrete structure tied into the sand, 9-in. Wakefield sheet piles 40 to 50 ft. long were driven for a distance of 96.5 ft. The weight of the intake, including equipment and water, varies from 1.1 to 1.9 tons per square foot of base area.

In the intake there are six openings, two for each penstock, and the dividing buttresses are grooved for stop logs and gates. Stop logs have been placed in front of the opening of the third penstock. For each of the other two penstocks there is a flat steel gate with a

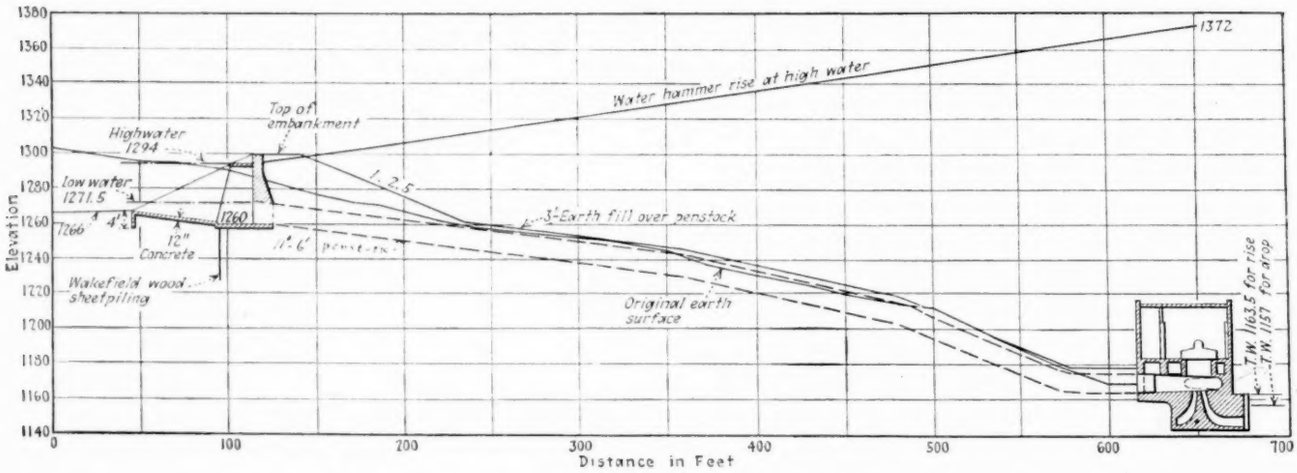


Fig. 4—Penstocks have been designed to stand with a safety factor of four, a 63 per cent water-hammer pressure rise

10-ton motor-driven hoist and a Broome gate with a 15-ton motor driven hoist. The latter does away with the necessity of a filler gate as it can be raised or lowered with the pressure of 34-ft. head of water against it. When letting the water into the penstock the Broome gate is raised first and the flat gate last. In closing off the flow of water to the penstocks the flat gate is lowered first and then the Broome gate. In this way the flat gate has a difference of only 15 in. in head against it when raised or lowered. The hoist motors, which are remotely controlled from a push-button station at one end of the intake, are protected by small individual wooden shelters. Float switches are provided at the intake to stop the units in the power house automatically when the pond is drawn down to a certain level.

Air inlets of 9 sq.ft. area are provided for each penstock. These are connected to a horizontal passage near the top of the intake and thence to one opening over which is a house with swinging doors. A small electric heater in this house will prevent the water in the air inlet shafts from freezing during the cold weather. The areas of the racks, gate openings and penstocks are such that the velocities of the water through them are respectively 1.75, 4 and 8.5 ft. per second.

Water is conveyed from the intake to the power house

through two steel penstocks 520 ft. long. A third penstock 110 ft. long for the future unit ends at the toe of the embankment below the intake. Under this fill all three penstocks are incased with one-foot thickness of concrete. The penstocks are 11 ft. 6 in. in diameter throughout. The plates vary from $\frac{3}{8}$ in. thickness with single-riveted joints at the intake to $\frac{13}{16}$-in. thickness with triple-riveted double-butt joints at the power house. They are designed to withstand with a factor of safety of four, a water-hammer pressure rise of 63 per cent at the power house, and a total static head of 202 ft. at that point.

This being a peak-load plant, it will stand idle for several hours each day. The winter temperatures often reach 40 deg. below zero, and to prevent the water from freezing in the penstocks they were laid in a trench and have a 3-ft. covering of earth.

Turbines of the vertical Francis type are installed over Moody spreading draft tubes with a central cone, the armored apex of which reaches to the bottom of the runner. These draft tubes were built in the reinforced mass concrete substructure. Each cone is reinforced vertically by 28 one-inch square bars grouted 3 ft. into solid rock and horizontally by 15 hoops of $\frac{3}{4}$ and 1-in. square bars (see Fig. 6). The spiral castings are incased in mass concrete.

The power house contains two units, but the east end of the superstructure has a temporary end of wood as it is expected in the near future the demands of the system will require the installation of the third unit.

The plant is built to be remotely controlled from Taylorville by the operator there closing oil switches on the transmission lines leading to Soft Maple. The

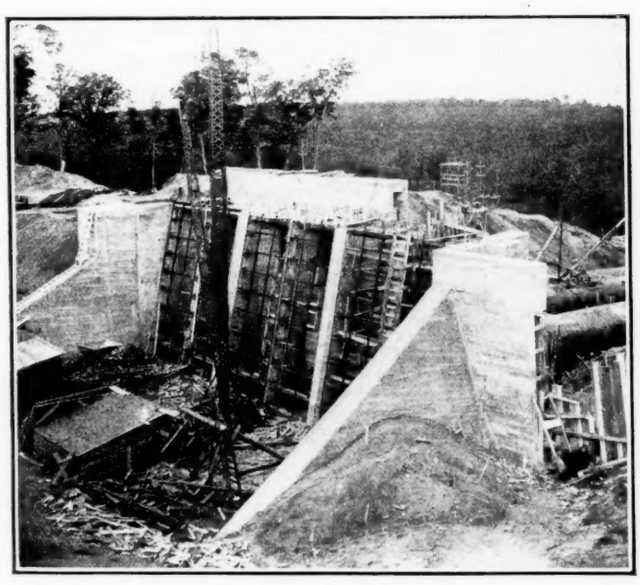


Fig. 5—Penstock concrete intake is supported on sand

transmission lines from Taylorville to Soft Maple have no connection to the plants between or above Soft Maple. The sequence of events to start a unit at Soft Maple are as follows:

By closing an oil switch at Taylorville the line to Soft Maple is energized, which in turn energizes a three-phase relay showing three-phase power in the right direction. This relay then closes the master contactor which energized the solenoid on the governor. The governor solenoid allows the gates to open rapidly to a certain point and the waterwheel starts. The gates then pause to allow the machine to come up to synchronous speed. At about 95 per cent of synchronous speed the speed switch closes and, provided the exciter has built up its voltage, which it does under normal conditions, the oil circuit breaker closes to connect the generator to the alternating-current line. Closing of the

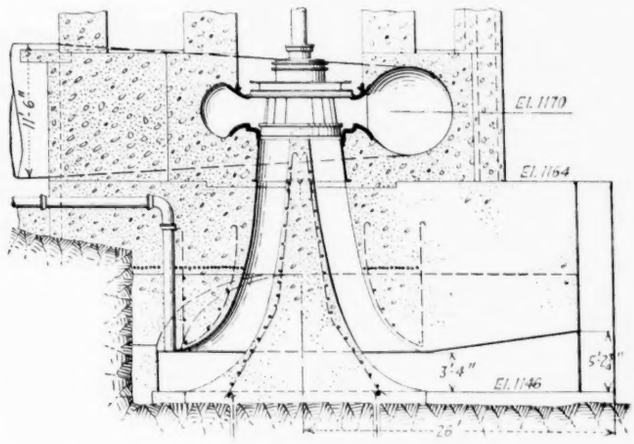


Fig. 6—Center core of draft tube is anchored to foundation rock with 28 one-inch square steel bars

oil switch completes a circuit and applies field to the generator which pulls into step and assumes its load. The second unit is started in a similar manner.

The plant was made automatic in consideration of operating economies, reliability and quick service in case of trouble. The additional equipment necessary to make the station automatic cost only a nominal sum.

The major items of equipment in the power house are two Wm. Cramp & Son 10,500-hp. vertical turbines, directly connected to two 9,375-kva. 60-cycle 6,600-volt General Electric generators. Woodward oil-pressure governors control the speed of the turbines, and a Northern Engineering Works traveling crane is provided for handling the equipment.

But one feature of the work remains undone, that of reforestation. Due to the large quantities of earth required to make the fills, the borrow pits were quite large. Eighty acres today are an eyesore. This spring thousands of pine seedlings were planted, and in a few years the ponds and the surroundings will become a beauty spot in the Adirondacks.

All work was under the supervision of W. P. Creager, vice-president and chief engineer of the Northern New York Utilities, Inc., and the Power Corporation of New York, who was assisted in his preliminary investigations by J. D. Justin. The work was designed in detail under the supervision of J. H. Gandolfo, chief designing engineer, and the writer, who had direct charge of all designing work. Electrical features were supervised by H. G. Davis, vice-president and operating manager of the companies mentioned, and his assistant, S. H. Abbey. Field construction was carried out by J. P. Brownell, assistant chief engineer, and J. J. Baker, resident engineer on the work. A. S. Crane acted as consulting engineer for the development.

The contractor for the development was the U. G. I. Contracting Co., Philadelphia, Pa., with W. M. Hall, construction engineer; Richard Byers, superintendent, and Charles D. Locher, consulting engineer.

The Human Power Plant

From an Engineering Viewpoint

By WILLIAM BREHMER

THERE probably is no more fascinating study, nor a more profitable one, than that of the human "engine." For every one of us is the sole owner and manager of a marvelous living power plant that is capable of marked improvement in operating results.

While it is true that living engines are very complex compared to the mechanisms man has learned to contrive, nevertheless the operation of these living engines is governed by certain basic principles that are not difficult to understand. In fact, the engineer with his practical knowledge of the principles of energy, should be among the first to perceive how and why the human engine "works" as it does.

THE author, an engineer whose hobby is biology, finds the engineering method of studying a system in terms of flow of materials and energy of great value in understanding the workings of the human power plant. This article, which is based on a study of recent experimental work in physiology, pictures the body as a power plant in which food energy is turned directly into electricity and then into mechanical work. The body is not a heat engine (although it produces heat as a byproduct); its efficiency is not limited by Carnot's ratio as is that of a steam or internal combustion plant.

It is well known that the early inventors and builders of power machinery had only vague ideas of the nature of such processes as combustion, steam generation and expansion, or of heat, electricity or chemical energy. Power engineering as a science began only with the precise study of the *energy changes* that took place in the various media used to drive the machinery. And as every engineer knows, the only way to determine precisely how a plant is operating, is to trace the flow of the energy-bearing media throughout the entire plant and to study the energy changes in these media.

This idea of studying the mechanism in terms of the energy that drives it is peculiarly helpful to an understanding of the complex phenomena of living engines.

The accompanying diagram shows in outline the way in which energy flows through the human power plant and, in so doing, makes it possible for us to perform the endless variety of things we are called upon to do. The great beauty of this "engineering" analysis of basic energy transformations is that it outlines the whole story without obliging us first to learn so many details of anatomy that we forget the forest in studying the trees.

Looking at the entire "plant" as a whole for a moment, we note that it absorbs chemical energy in the form of foods (begin at upper left-hand corner). This chemical energy is subsequently transformed within the muscles into: (1) Electrical energy, which is the basis of nerve and brain processes; (2) mechanical energy (muscular contractions), by which motion and physical work are effected; (3) heat, which accelerates all the vital processes and keeps the organism warm.

In other words, the living engine works on the energy sequence: Chemical—electrical—mechanical—thermal. Whereas, our modern power plants work on the sequence: Chemical—thermal—mechanical—electrical.

Thus, the living engine is not primarily a heat engine depending upon the combustion of fuel, but an electrochemical engine in which heat is a useful byproduct. This will become clearer as we go into the details.

Beginning now at the left, we note that the engine absorbs certain energy-bearing substances that we call foods. Now, we must not think of these foods as so many different kinds of "stuff." We must think of them rather in terms of the peculiar energies which are wrapped up in them.

For example, we know quite well that cane sugar contains carbon, hydrogen and oxygen in the exact proportions 12, 22 and 11. But when we eat sugar it is not to obtain carbon, hydrogen and oxygen as such. We really "eat" the peculiar energies that have been wrapped up in the sugar particles by the growing plant acting under the driving power of the sun's radiations.

The first action of the organism is to digest the crude foodstuffs, that is, refine them and separate out of them the most desirable of their energy-bearing constituents. This process is effected in the mouth, the stomach and the intestines as shown. In detail it is a most complex process, but for our purpose it is enough to know that the most select of the raw energies are made suitable for direct usage later on by the power generators.

The next stage in the progress of energy through the organism is the absorption by the blood of the choice energy-bearing particles through the intestinal walls. The blood is essentially a hydraulic transport medium flowing in a closed system as shown, and serving the purpose of distributing the energy-bearing substances to every one of the trillions of living cells throughout the organism.

After passing through the liver—a kind of energy storehouse, refinery and digestion regulator—the blood goes to the small, right chamber of the two-chambered pump, the heart. Thence it is pumped through the lungs.

Now, the lungs have a very porous, spongy structure whose aggregate surface area, if developed, would cover some 1,300 sq.ft. This lung area is about 100 times the external area of the body. Only the finest of membranes separate the blood from the air, so that we can appreciate how vital good air is to the individual.

The blood is a very complex fluid and contains, among other things, a myriad of minute, disk-like cells, the so-called red corpuscles. These cells contain a remarkable substance, haemoglobin, which can absorb and hold loosely and interchangeably, either carbon dioxide or oxygen. As the blood courses through the lungs, the red corpuscles part with CO_2 derived from energy transformations (to be described) and absorb oxygen from the air.

The blood, now enriched with fresh energy supplies for all needs, is pumped by the left[1] heart chamber throughout the entire "works," touching every one of the trillions of cells.

The Muscle Batteries

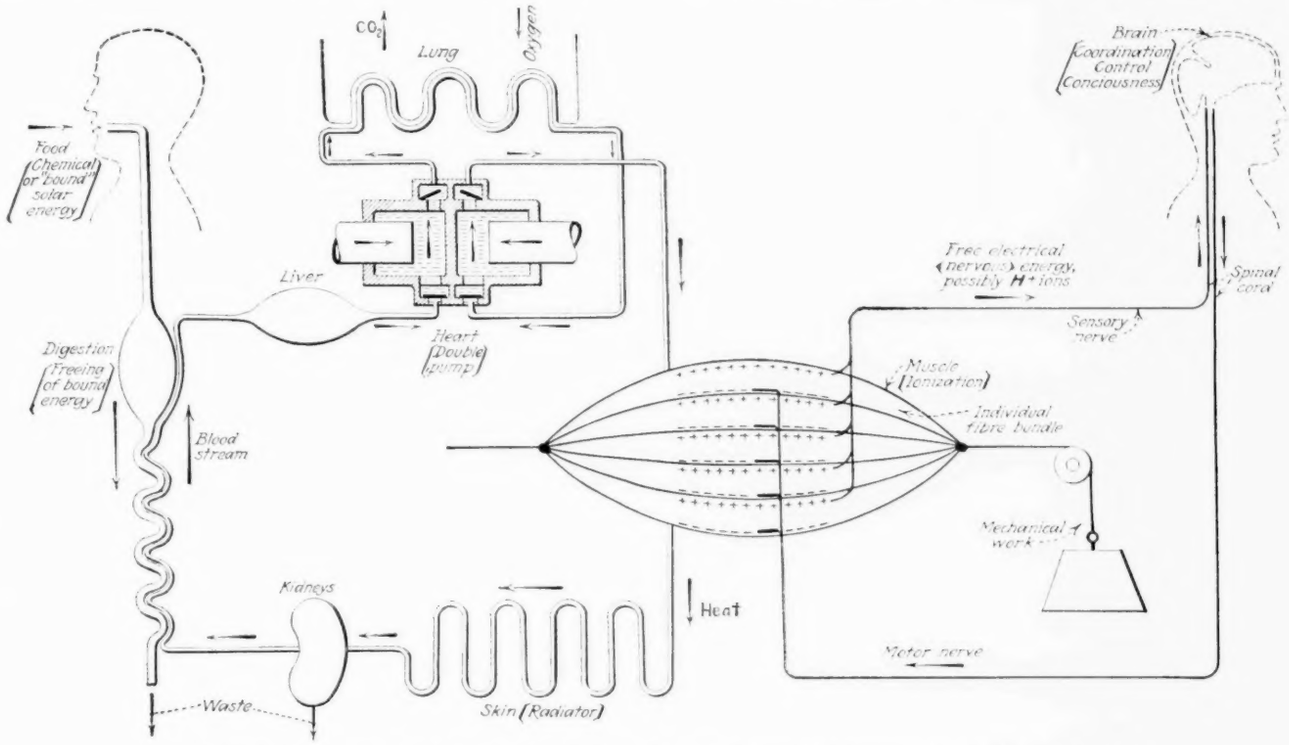
The next important stage in the wonderful life process consists of a series of related energy transformations which take place in muscle tissue. In a normal man weighing 150 lb. the weight of the muscles is about 60 lb., while the weight of the brain is only about 3 lb. As everybody knows, the brain is the very center of our living. Yet, in order to understand the working of the brain we must first analyze the energy changes that occur in the muscles.

The human power plant contains about 200 pairs of muscles. Each muscle consists of a number of bundles of very fine, long fiber cells. The average length of these fiber cells is about one inch, and their average diameter about one five-hundredth of an inch. Each bundle of fibers is sheathed in a membrane which separates it from its neighboring bundles, mechanically and electrically.

Each muscle is connected to the central nervous system through two separate nerves. One of these, the so-called "sensory" nerve, is of rather fine construction. The other, the so-called "motor" nerve, is of heavy construction and has separate "plate terminals" on each bundle, as shown in the diagram. For the sake of simplicity the entire muscular system of the body is represented by only one large muscle.

So far as can be ascertained, each bundle of fibers is really a primary electric battery. But, unlike the simple rigid batteries with which engineers are familiar, the muscle battery is capable of marked changes in length. It is thus capable of performing mechanical work. Human knowledge has not yet progressed to the point where we can say positively how the muscles operate. The following explanation seems the most reasonable in the light of recent investigations.

The remarkable electro-mechanical properties of the muscle are probably due to the long, fine fiber cells. It is well known that the surface of any liquid or semi-liquid body, whether it be a rain drop or a blob of mercury or a living cell, is in a state of tension. It is this so-called surface tension which enables a water bug to walk on water, or even a steel needle to float on its surface.



Flow diagram of the human power plant showing how the energy in food is utilized

The muscle cells have a very high surface tension because, for one thing, they have so much surface area. A single muscle may contain several hundred thousand of these fiber cells closely packed together, so that it is not difficult to conceive of the total amount of tension such a structure is capable of developing.

As the blood passes through a muscle, the energy-bearing substances which it contains tend to adhere to the sticky surfaces of the muscle cells. And since there are so very many of these cells, the muscle is capable of storing a great amount of energy. Thus, we see that the muscles are great energy concentrators.

Now, according to this theory the tensed condition of the muscle-cell surfaces causes the food particles to split up into positively and negatively electrified sub-particles

[1]The left heart chamber is represented by the right side of the pump in the sketch.

which we call ions. Thus, the so-called chemical energy of the food particles is converted directly into electrical energy.

The positive and negative ions which are formed within the separate muscle bundles arrange themselves into alternate layers (+) and (—), as shown in the diagram. The (+) ions tend to repel each other along one side of the muscle bundle, while the (—) ions tend to repel each other along the opposite side. This self-repulsion of both kinds of ions along the length of the muscle fibers tends to neutralize the surface tension inherent in the fibers. Hence, our muscles are ordinarily relaxed.

Thus, we see that the muscles are primarily transformers of chemical energy—that is, energy bound up in complex substances—into that most ideal form of energy, the electrical. In other words, man is essentially an electrochemical-mechanical engine.

The Nervous System

We are now in a position to inquire into the intimate nature of so-called nervous and brain processes. To begin with, it is well known that nerve and brain tissues have a high electro-conductivity; secondly, the nervous impulses flow in only one direction along any given nerve; thirdly, each muscle is connected to the nervous system through two separate nerves, as shown in the diagram.

These considerations lead us to believe that the nervous system is a vast network of electrical conductors which interconnect all the organs of the body. And the function of the brain is to regulate and use for the best interests of the individual the electrical energy "generated" within the trillions of body cells. Thus, such marvelous processes as thinking, feeling, visualizing, aspiring, initiating, "willing" and so on correspond to the flow of minute electric currents through this intricate, self-acting "switchboard" of one's total energies—the brain.

These currents arise in the muscles, in the eyes, ears, nose, mouth, and in myriads of delicate organs of touch, pressure, temperature, etc., that are scattered throughout the entire organism. Since the number of brain cells runs up in the billions, there is practically an infinite number of ways in which energy can flow through the brain. All of which is another way of saying there is almost no limit to the things the human mind can accomplish.

We may now proceed to complete the picture of the flow of energy through the human power plant. Referring again to the diagram, we have seen how the muscles convert the chemical energies they receive through the blood stream into positive ions and negative ions.

Of these two types of ions which are segregated within each muscle bundle, one seems to be able to free itself from the sheathed bundle via the fine sensory-nerve ending. In the diagram we have shown this ion as the (+) ion. Very likely this ability to escape from the muscles is due to the fact that this ion is a very tiny one. The negative ion, however, seems to be too big to get out of the muscle. It seems to collect around the heavy plate-ending of the motor nerve.

Whatever the mechanism for "closing" the nerve circuits may be, the waking hours of a person are marked by a continual, but ever-varying procession through the brain of electrically charged particles which come up the sensory nerves from the muscles. After passing through the brain, they go down the so-called "motor" nerves to the muscles, thus completing the circuit.

What we call consciousness seems to be the complex sensation aroused within the brain by this flow of activating ions. What we call sleep seems to be a lull in the flow of this brain current. Apparently, it requires much time and rest for the muscles and brain to store up the ions needed for the daily round of activities. Hence, we sleep. When the batteries are again charged and current begins to flow through the brain, we wake up.

The Progress of Mankind

Engineers know well enough that the advance of our civilization is intimately dependent upon the generation of more and more electrical energy and the use of this energy in an increasing number of ways. This is simply because electricity is the "purest," the most concentrated and the quickest acting of all the forms of energy known to us.

What does not seem to have been appreciated, however, is the bare, simple fact that man is within himself a great generator and user of electricity. It is to this basic fact that he owes his unique leadership in the procession of life.

The Nature of Motion

Although the highest, most valued uses for our electrical energies are within the brain, it is well known to all of us that these uses do not acquire tangible values until we put our thoughts into action—into physical motion. This action, however slight, requires the use of our muscles as organs of motion. That is, we must use our primary electric batteries as mechanical motors.

All physical action depends upon muscular contraction. We have already noted that the surfaces of the long fiber cells of a muscle are in a state of tension. This would ordinarily make the muscle contract were it not for the fact that the electrified particles (ions) which are always present within the muscle counterbalance the inherent tension.

Suppose you decide upon a certain action—giving a verbal order, rising from a chair, taking a few steps, using a tool or what not. This action will cause the usage of a certain number of muscles as motors. That is, you will supply these muscles with electric current. To supply this current you have the entire muscular system to draw upon.

Now, in some complicated way which we will not attempt to describe, the brain has the power of drawing upon the stored (+) ions of the entire muscular system, of concentrating these and of switching them in the form of heavy charges down the motor nerves of the muscles to be contracted.

Referring for a moment to the diagram, we have already seen how the (+) and (—) ions arrange themselves in parallel layers with the (—) ions near the heavy terminals of the motor nerve. When a series of heavy charges of (+) ions comes down the motor nerve of a given muscle, these (+) ions combine with the (—) ions near the nerve terminal. As the (—) ions are thus neutralized, the tension inherent in the muscle fibers begins to assert itself. Thus, the muscle begins to contract. Furthermore, as the muscle contracts, its own (+) ions begin to leave it in proportion to the amount of (—) ions which have been neutralized.

Hence, the muscle contracts even harder than it would if it were only a question of neutralizing the (—) ions.

Thus, we see that the action of the nerve-muscle system, however complex it may be in the ramifications of its details, is not especially difficult to understand in principle.

To complete the energy cycle of the human power plant we have but to consider the heat which it generates.

Only a moment ago we saw how muscular contraction was effected through the neutralizing of the (—) ions by (+) ions. Now, it has been quite definitely established that this reaction of (+) and (—) ions results in the formation of a substance called lactic acid. Furthermore, it is well known that the presence of lactic acid in a muscle makes the muscle very tired. That is, you can take the lactic acid which has been formed in a muscle that has been contracted vigorously, inject it in a fresh muscle, and immediately the fresh muscle will become tired.

Muscles More Efficient Than Heat Engines

So, while Nature was solving the problem of producing a generator-motor like a muscle, she was obliged, also, to solve the problem of removing immediately any substances that "back-fired." For this purpose she used that common, yet wonderfully "live" substance, oxygen. That is, lactic acid which has the formula $C_3H_6O_3$, is readily oxidized to produce CO_2 and H_2O. These are easily removed by the blood.

This is really why we breathe oxygen. The use of oxygen in the living power plant is radically different from its use in a steam or gas-engine plant.

As engineers know, any heat engine is inherently quite inefficient, for the simple reason that there is a well-defined limit to the amount of energy you can abstract from the vibrating molecules of a hot gas. But electrical and electrochemical engines may be exceedingly efficient. Recent experiments have shown that a fresh muscle is practically 100 per cent efficient. With continual use and without a chance to recuperate, this initial efficiency falls off rapidly.

It is well known that although the average efficiency of the muscles is well over 50 per cent, the efficiency of the plant as a whole is rarely over 30 per cent. This is due to the fact that so much heat is generated even when a person is asleep.

In a certain sense this heat represents a wastage of energy. But in a broader sense we must regard it as an indispensable byproduct, because the maintenance of a high temperature level, that is, 98 deg. F., greatly accelerates the speed and complexity of our basic vital processes. This is proved by the fact that warm-blooded mammals have as a whole risen to much higher life levels than their cooler-blooded cousins.

Power engineers know that the basic problem of plant operation is to secure the greatest amount of electrical energy at the switchboard per pound of fuel consumed. Similarly, it would seem that the great human problem of science is to find out how the individual may secure a greater flow of electrical energy through the brain.

Considering how very young, but how very lusty the science of human energy is, it would seem that we have a right to look forward with much hope to some definite progress along these lines of research. It is hoped that this tentative "engineering" analysis of the human engine may stimulate new interest and activity in this great human quest.

Fish Stop the Operation of Hydraulic Turbines

By M. B. Thurston

A night letter from a large hydro-electric plant in the Atlantic States, started me toward this installation. All the units were acting mysteriously; they vibrated, then would slow down, then speed up. Regulation had gone completely to pot, and it was necessary to drop most of the load. "Send a man at once!" That was the gist of their one-hundred-word night letter.

This plant is on a pretty fair-sized stream flowing into the Hudson River, and not any too much water was available at that time. I got on the job and by way of experiment started a man taking the exciter turbine apart since the whole plant was down. My helper just about had the covers loosened, when out gushed a stream of blood and an odor that Irvin S. Cobb calls "that bird and animal store smell." I did not know what was coming, but further work on the backing-off screws resulted in more blood and then piles of badly churned fish falling out. They once were eels. They were so firmly wedged in by the pressure of a 98-ft. head that removal was difficult. Cutting them out with borrowed butcher's knives finally cleared the exciter runner.

The large units showed similar conditions, except that one runner had three pieces of 2x4 lumber wedged into the small end of the vanes besides being chock full of ground fish. I was about to leave, having finished up and made everybody happy, when a telegram came for me to go to a flour mill in Jersey, where a man had bought one of our small standard wheels and had put it in himself. The head was 12 ft., and the draft head was 6 ft., or half of the whole fall. His complaint was that he got only half the rated power out of the wheel and he wanted someone to find out what was wrong. The little turbine was found all set up and a fine job it was, but where was the draft tube? Didn't they send him any? He knew nothing of any such thing. So I began looking around. A construction gang working on a canal near-by aroused my suspicions. Sure enough, they had swiped the draft tube and used it for a smokestack on an old locomotive boiler! It was a trifle large, but what of that? The flour-mill man's name was painted on it, and a poor effort had been made to smear it off. After some difficulty and threats of arrest, we rescued the draft tube, unpleasantly hot. In due season it was bolted on the turbine casing, after which the unit developed ample power.

In drawing up the oil-engine cylinder heads, the nuts should all be run up snugly. Then one nut should be tightened a part turn, followed by the tightening of the nut on the opposite stud. After all nuts are tightened fairly well, a sledge or heavy hammer should be used on each nut. All studs and nuts should be numbered so that the proper nut goes on its stud. If a nut turns down hard, it should be lapped with emery paste, so that it turns easily by hand. No nut should be marred or damaged by the use of a chisel to tighten or loosen.

In the June 29 Issue the article, "Automatic Regulation Maintains Exhaust and Bleeder Pressures" neglected to mention that John A. Stevens and his associated engineers were consulting engineers on the Lever Brothers Plant.

Operation of Voltage Regulators for Alternating-Current Generators

Principles on Which Voltage Regulators Operate—Function of the Direct-Current and the Alternating-Current Systems in the Regulator—Adjusting Regulators To Hold Constant Exciter Voltage or Constant Alternator Voltage—Taking Care of the Regulator

By W. H. TURNER
Flow-Meter and Regulator Engineering Department, General Electric Company

CONSTANT voltage is an important factor in furnishing satisfactory electric-power service. Voltages higher than normal result in increased transformer losses and lamp renewals. Voltages lower than normal result in revenue losses and dissatisfied customers for central stations.

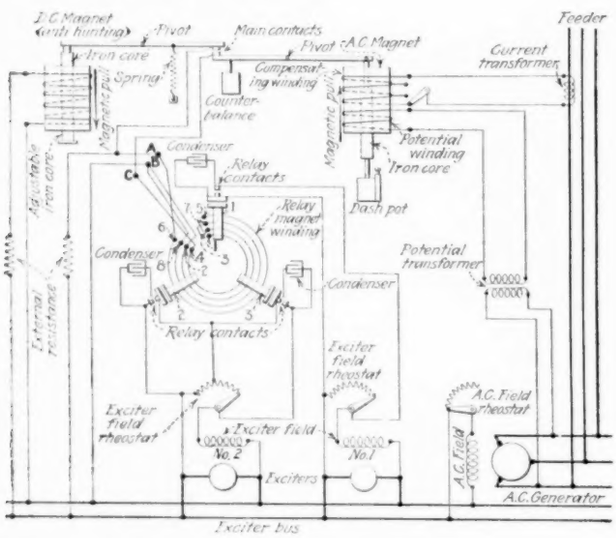


Fig. 1—Simplified diagram of voltage regulator connections

Present-day alternating-current generators, for operating reasons, have poor inherent regulation, and it is practically impossible to hold a satisfactory constant voltage by hand. With these generators this can be accomplished by using automatic voltage regulators of the vibrating type. The voltage of the alternator is held practically constant by the automatic opening and closing of a shunt circuit across the exciter field rheostat, thus varying the exciter voltage to meet the excitation requirements of the generator. The alternator's field rheostat is usually turned to the all-out position, thus eliminating the heating loss of this rheostat. The exciter armature voltage is reduced to that which is actually required across the field of the alternator. When under regulator control the exciter voltage is held stable even at very low values, approaching to within a few volts of residual if necessary, and a reversal of exciter voltage is almost impossible.

With large units it is becoming general practice to install a regulator with each generator with its individual exciter. Stability between generators is assured and wattless swings are avoided by the use of an out-of-phase current transformer connected to the current winding of the regulator. The vibrating regulator not only holds steady alternating-current voltage, but tends to hold the units more firmly in parallel. Furthermore, in times of disturbance the regulator relieves the operators of the duty of attempting to adjust the alternating-current voltage. In case a large block of load is switched on the system, the regulator immediately strengthens the excitation of the alternators' field poles, not only holding the alternating-current voltage constant, but increasing the synchronizing power to hold the machines in parallel. If a large block of load is tripped from the system, the regulator immediately reduces the exciter voltage and prevents excessive rise in alternating-current voltage with its bad effects.

Regulator Adjustment a Simple Operation

Contrary to the general opinion the functioning and adjustments of the regulator are quite simple. The following description applies to the standard vibrating regulator which has one main control alternating-current magnet, and one direct-current main control magnet and direct-current relay magnets. It should be borne in mind that this regulator consists of two parts, a direct-current system and an alternating-current system. The former is simply a direct-current regulator having a main control magnet and relay magnets connected across the exciter mains, the contacts of the relays arranged to shunt the exciter field rheostat. This direct-current regulator maintains not a constant but a varying exciter voltage, the value varying in accordance with the demands of the alternating-current control magnet which is connected to the alternating-current bus by means of a potential transformer.

Referring to the elementary diagram, Fig. 1, this shows the direct-current control magnet connected across the exciter bus and provided with two cores, the lower being a fixed core, the upper a movable core attached to a pivoted lever at the opposite end of which is mounted a contact. The pull of the magnet is shown opposed by one spring, but in practice there are four springs in multiple adjusted to pick up at different exciter voltages, as shown at *S*, Fig. 2. The use of four springs increases the sensitivity of the direct-current magnet. Thus, on low exciter voltages, the pull of the magnet is opposed by one spring only, but

on high exciter voltages the magnet is opposed by all four springs.

A differentially wound relay magnet is also shown connected to the exciter bus, one winding being permanently connected to the bus, while the other is arranged to be opened and closed by the floating main contacts. When the main contacts are closed, both windings of relay magnet are energized, neutralizing each other and allowing the relay springs to close the relay contacts. When the main contacts are open, only one relay winding is energized and the pull caused by this winding overpowers the pull of the relay springs and opens the relay contacts. Ordinarily, the rate of vibration is from 200 to 300 times per minute.

Two exciters are shown connected in parallel across the exciter bus. No. 1 exciter has one relay contact connected across its field rheostat. When this contact closes, the rheostat is short-circuited. It is the rapid opening and closing of these contacts that controls the voltage, the voltage tending to rise when the contacts close and tending to decrease when they are open and the field rheostat is in circuit. Exciter No. 2 has two sets of relay contacts connected to its field rheostat. Any number of relay contacts can be connected to the rheostat of an exciter, the number depending upon the voltage and field current of the exciter to be controlled. In one case four small exciters were controlled by one set of relay contacts, and in another one large exciter required 60 sets of relay contacts.

The potential winding of the alternating-current control magnet, Fig. 1, is shown connected across the generator bus through a potential transformer. This magnet is of the ordinary solenoid type having a laminated iron core which is attracted upward by the magnetizing force. The pull of the magnet is assisted by a counterweight which is at the opposite end of the pivoted lever. Adding weight to the counterweight cup causes the regulator to hold a lower alternating-current voltage, whereas removing weight from the cup causes the regulator to hold a higher alternating-current voltage. In this manner the secondary alterrating-current voltage of the potential transformer can be set at any value between 100 and 125 volts. In case it is desired to change the value of the regulated alternating-current voltage frequently, an adjusting rheostat can be connected in series with the potential winding of the solenoid.

At any constant load, speed and power factor, the alternating-current magnet core does not move, but the direct-current part of the regulator acts as a direct-current regulator, maintaining the proper exciter voltage to give the correct alternating voltage. If load is thrown on the generator, the alternating-current voltage would tend to drop and the core of the alternating-current solenoid would assume a slightly lower position and the main contacts a corresponding higher position, which would call for a higher exciter voltage in order to maintain the alternating-voltage constant.

The alternating-current solenoid core, on changes in load, travels either up or down, demanding an exciter voltage that will result in the proper alternating-current voltage. The travel of the core can be blocked by limit pins, thus preventing the regulator from holding the alternating-current voltage, but holding instead, the exciter voltage constant. The upper limit pin is for adjusting the minimum exciter voltage. When the alternating-current regulator lever touches the lower limit pin, the exciter voltage is held constant at a maximum value. The alternating-current lever must be between the two limit pins, or in the so-called "floating" position when holding alternating-current voltage.

The direct-current main control magnet of this regulator adapts itself automatically to any exciter, small or large, fast or slow. Any voltage regulator must have a good means of anti-hunting in order to be

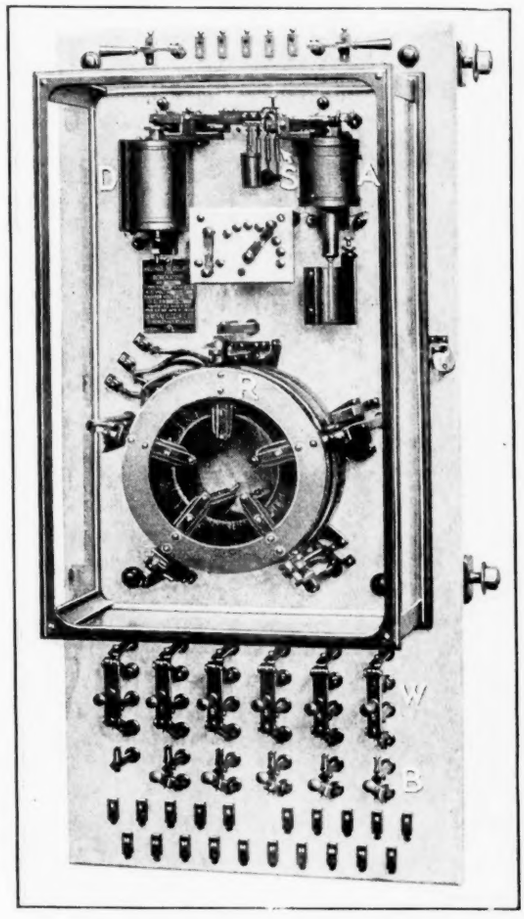


Fig. 2—Front view of voltage regulator

A—Alternating-current control magnet. *D*—Direct-current control magnet. *R*—Relay magnet with five contacts. *W*—Relay contact reversing switches. *B*—Relay-contact disconnect switches. *S*—Tension springs on direct-current control-magnet contact arm.

successful. The direct-current magnet of this regulator is not only an anti-hunting magnet but a sensitive anticipating magnet. Assuming that the alternating-current control magnet is connected to the generator bus, and that there is no change in load or speed of the generator, the position of the alternating-current core and lever will not change. Assuming that the exciter is separately driven and, due to low water or steam pressure, the speed drops, it would tend to lower the exciter voltage. As the anti-hunting magnet is connected directly across the exciter mains, it is affected by the slight drop in exciter voltage, and closes the contacts, which increases the exciter voltage before the alternating-current voltage has actually changed owing to the change in exciter voltage. Any regulator that obtains its anti-hunting characteristics from the alternating-current side must have a change in load current before it will correct for changes in speed or load.

Erecting Cross-Drum Boilers

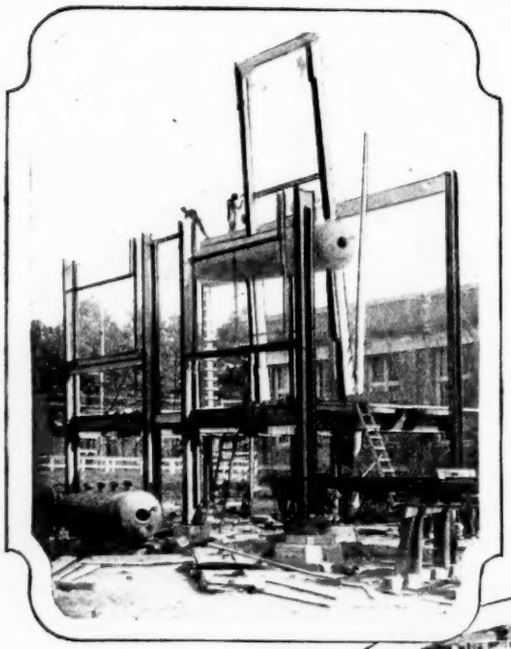


Fig. 1 (above) Raising the drums into position

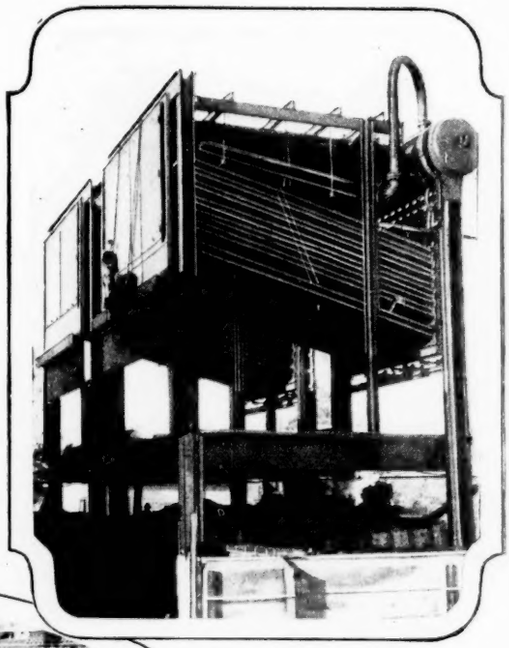


Fig. 2 (above) Drums and tubes assembled

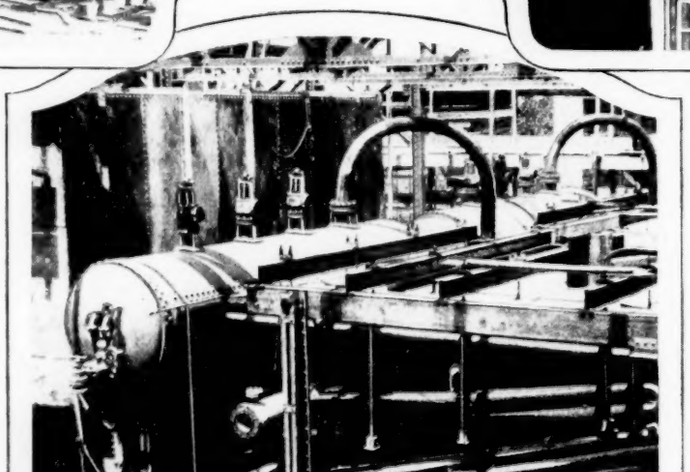


Fig. 3 (right) Putting in the roof tile

Fig. 4 (below) The stoker is being erected

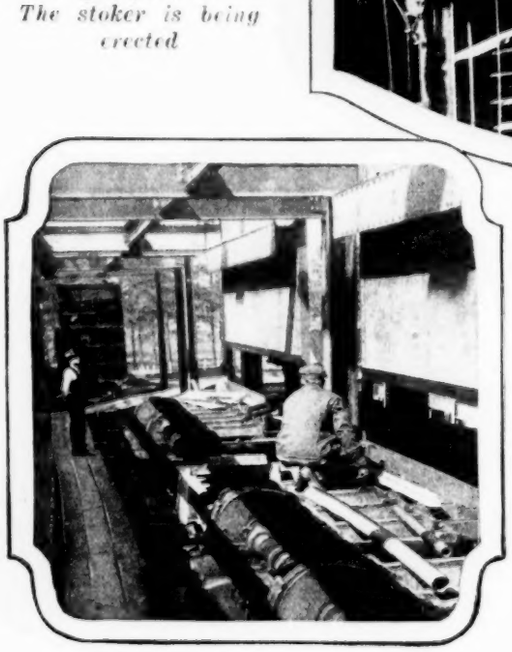
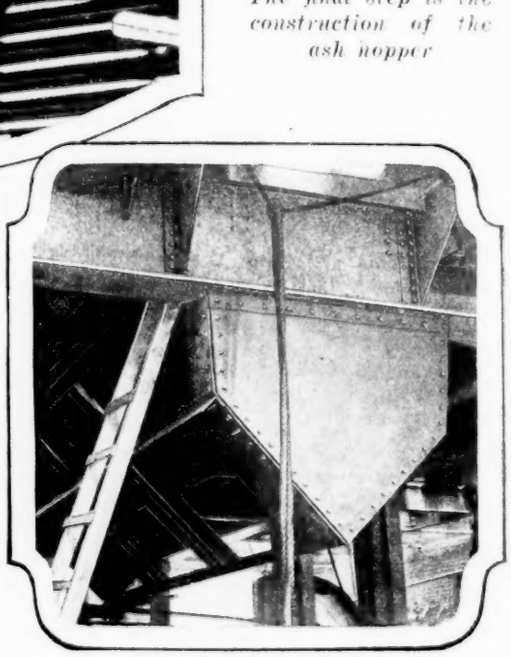


Fig. 5 (below) The final step is the construction of the ash hopper



Three-Stage Air Ejector Uses Less Steam

By D. W. R. MORGAN
Engineer in Charge of Condenser Department, Westinghouse Electric & Manufacturing Company

WHATEVER the design, operating conditions determine both economy and capacity. It may be better to use raw condensing water, wasting some heat, than to use condensate and reduce the pump capacity.

THE development of turbine-generator units in recent years indicates that only slight gains in efficiency may be expected from modifications of design; however, considerable improvement is possible by increasing the initial steam pressure, but this can be attained only with an appreciable increase in cost of boilers and auxiliary equipment. It naturally follows that an effort should be made to reduce the power requirements or steam consumption of the auxiliaries serving the main unit, and much has been accomplished in improving the efficiency of centrifugal pumps and of hydraulic and steam-jet air pumps.

The type and arrangement of apparatus used for evacuating non-condensable gas from the condenser should be given serious consideration, first because of their relation to main unit economy, and second, because of the steam consumption or power required to perform this function. For example, assume a 30,000-kw. turbine having a steam rate of 10 lb. per kw.-hr., with an average exhaust pressure of 1 in. of mercury, absolute, and assume an air leakage into the condensing system of 15 cu.ft. of free air per minute. This requires a steam-jet air pump consuming 1,600 lb. of steam per hour, which is approximately one-half of one per cent of the steam required by the main unit. This condition actually exists in many plants. By diligence and good management air leakage can be reduced to approximately 5.6 cu.ft. of free air per minute. The steam consumption will then be 600 lb. per hour, or approximately one-quarter of one per cent of the total.

It may be argued that the steam consumption of the steam-jet air pump is not of great importance because practically all of the heat is absorbed in the condensate. The fallacy in the argument, however, lies in the fact that the equivalent heat can be obtained at lower cost by the use of extracted steam, particularly from the lower pressure stages of the main turbine.

Marked improvement has been made in the efficiency or reduction in steam consumption of the jet type of air pump of equivalent air removal capacity since its introduction in this country:

Year	Lb. Motive Steam per lb. free dry air at 1 in. of mercury absolute pressure	
1913	41.9	Non-condensing type
1923	11.75	Condensing type
1926	9.00	Condensing type

The design offered in 1913 consisted of a two-stage, multiple-nozzle, tandem compound ejector of the non-condensing type, in which the second stage was required to evacuate steam as well as gas from the first stage.

The steam consumption was reduced approximately 60 per cent by interposing a combined condenser and cooler between the first and second stages, thereby reducing the work to be done by the second-stage nozzles. Further improvements were made by changing the proportions of the diffuser and the location of the steam nozzles with respect to the diffuser throat, and research along these lines is being continued.

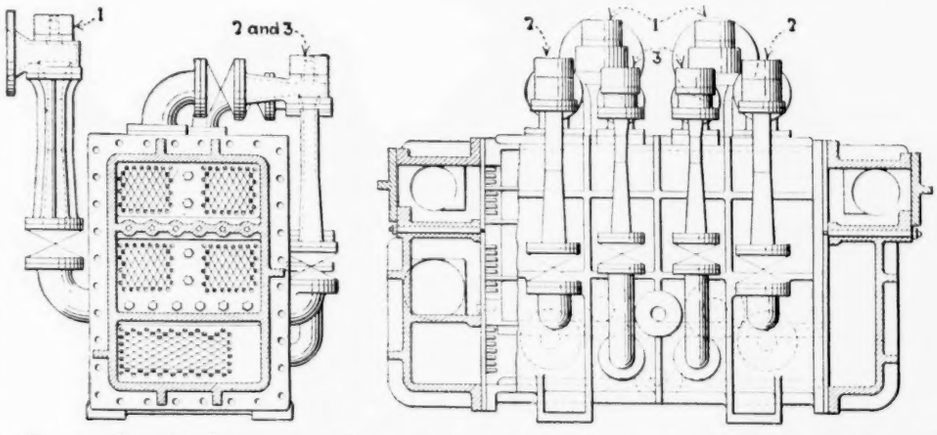


Fig. 1—A twin three-stage ejector with inter- and after-condensers cuts 30 to 40 per cent from the steam requirement

In order to realize further reduction in steam consumption, the Westinghouse company has completed the development of a three-stage condensing-type ejector, illustrated by Fig. 1. The apparatus consists of three single-nozzle ejectors in series, with a combined condenser and cooler interposed after each stage, the third stage finally discharging into the aftercooler.

The belief that the use of multiple nozzles, consisting of a rosette of small nozzles, yields higher efficiency than a single nozzle can be substantiated by comparing the efficiency of multiple versus single nozzles, using the same proportions for the entraining area, diffuser

throats, etc. On the other hand, with all parts of the ejector properly proportioned for the best result, equal efficiency can be obtained with single nozzles in each stage for capacities and pressures within the limits encountered for condenser application, and this design has the advantage of eliminating the use of nozzles with minute throats which readily become choked.

The three-stage design permits a reduction in steam consumption for a given amount of air for the same reason as that given for the introduction of the condenser and cooler for the two-stage condensing type.

The increase in air-handling capacity of a three-stage ejector as compared with a two-stage is more pronounced at the lower absolute pressures, as would be expected owing to the elimination of motive steam and the early cooling of the gas by introducing the additional condenser and cooler.

Compared with the two-stage condensing-type ejector, the decrease in steam consumption is approximately 30 per cent at 2 in. of mercury absolute, 33 per cent at 1 in., 40 per cent at 0.75 in., and 63 per cent at 0.5 in.

The three-stage ejector permits a lower absolute pressure at shutoff, which is advantageous, because, generally speaking, a high vacuum at shutoff results in greater air-handling capacity for a given steam consumption within the range from 0.5 in. to 1.2 in. of mercury absolute. It is obvious that an ejector capable of producing only 0.5 in. at shutoff will have very little capacity available in the range from 1.0 to 0.5 in.

There are many installations in operation where the economy of the main unit is affected because the air-removal equipment does not have sufficient capacity through the range from 1.2 in. to 0.7 in. absolute. It follows, then, that the problem is to produce a steam-jet air pump having an appreciable air-handling capacity over that range, and to secure the highest economy.

Cooling Medium

For the dual purpose of condensing the motive steam and cooling the non-condensable gas, either jet or surface type coolers are employed, the surface or tubular type having some general preference.

Water is used as the cooling medium, and the source may be condensate, a combination of condensate and raw water, or raw water only, the latter bypassed from the main condenser circulating system. The use of condensate is to be preferred if sufficient quantity is available, for by this means practically all the heat from the motive steam is restored to the system. In installations where there is insufficient condensate, particularly at light loads, the combination of condensate and boiler-feed makeup or raw water should be used.

Emphasis has been placed on reducing the steam consumption of the air-removal pump. It is of equal importance, however, to analyze and determine the reduction in air-removal capacity due to increased temperature of condensate and variable amounts of condensate. The effect on capacity due to changes in temperature is illustrated by Fig. 2. Likewise, reducing the quantity of condensate at a given temperature produces a similar effect.

This phase of the steam-jet air-pump application is not generally understood or appreciated. The effect is quite noticeable in installations where condensate is used as a cooling medium for the generator air cooler, transformers and oil coolers, for the dual purpose of conserving heat and assuring a supply of clean water for these auxiliaries. This practice has practically no thermal saving over securing the corresponding heat in the condensate by bleeding one of the lower stages of the turbine, and has the disadvantage of raising the temperature of the water in the ejector coolers, impairing condenser performance, as shown in Fig. 2.

The piping arrangement to and from the ejector may be simplified by using raw water only or raw water through the intermediate condenser and cooler and condensate through the after-condenser. Tubes can be kept reasonably free of débris by the use of a twin strainer or similar device. This plan might be justified by the improved economy of the main unit at low loads when there is usually insufficient condensate to condense the steam and cool the gas.

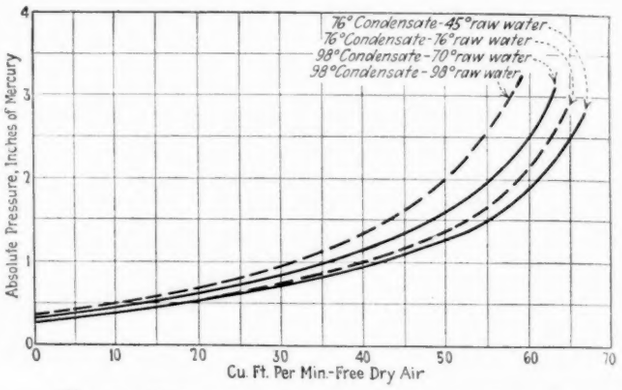


Fig. 2—Hot water reduces air ejector capacity

Operating Pressure of Steam Jet Nozzles

Requiring a pressure of the order of 125 lb. per sq.in. gage seems unreasonable where the operating pressure is 300 lb. to 400 lb. and is fairly constant. It represents a loss in heat to effect reductions from 400 lb. to 125 lb. and incidentally results in poorer economy of the steam jet. It is therefore more desirable for 300 to 400 lb. initial pressure to design the ejector nozzles for 200 or 250 lb. rather than 125 lb. Where the initial pressure is 250 lb. or under, there is no necessity for designing the ejector for a drop in pressure in excess of 50 lb. between the high-pressure steam line and the ejector nozzle inlet.

Experience has shown that maximum reliability can be obtained by using an orifice plate to obtain the reduced steam pressure required at the steam jet, with a suitable bypass and valve for use in case of emergency. Not much success has been secured by the use of reducing valves.

When contemplating the use of a steam-jet air pump there are several factors to consider:

First, determine the range of suction pressure under which the ejector must operate, bearing in mind that a three-stage is more efficient than a two-stage ejector over the range from 1.2 in. to 0.5 in. For pressures above 1.2 in. little is to be gained by the third stage.

Second, the design having the least number of motive steam nozzles should be used, for there is less chance of nozzles becoming plugged with foreign matter carried over with the steam.

Third, the load conditions should be analyzed for the purpose of determining whether there is sufficient condensate available at all times to condense the motive steam and cool the non-condensable gas.

Boiler Feed-Water Purification—IV

Softening Water by Chemicals*

Chemistry of Softening—Intermittent and Continuous Softeners—Operation of Continuous Cold-Process Plant—Cost of Treatment

By SHEPPARD T. POWELL
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THE working of chemical precipitation water softeners depends upon the addition to hard water of certain chemicals which convert the soluble scale-forming solids into insoluble forms. In the latter condition they are removed by settling or filtration. There are many different designs of softeners of this kind, but the basic principle of operation of all is the same. The hardness of water is due principally to the presence of carbonates, bicarbonates and sulphates of calcium and magnesium. Chlorides and nitrates of these elements and forms of iron, aluminum and manganese are the causes of hard water at times, but these forms are not ordinarily found in appreciable quantities.

It has been customary in the past to speak of the hardness of water as either temporary or permanent. Temporarily hard waters are those that can be softened by boiling, and permanently hard waters are those whose hardness is not changed by this action. Carbonate and non-carbonate hardness are more accurately descriptive of these types and are preferable terms. The solubility of bicarbonates of calcium, magnesium and other elements is due largely to the presence of carbonic acid. When this is removed by heat or by chemicals, the bicarbonates are reduced to normal or mono-carbonates. These forms have a much lower solubility than the bicarbonates and are, therefore, precipitated.

A number of chemicals may be used to absorb the carbonic acid, although lime is almost always employed for this purpose. When caustic lime ($Ca(OH)_2$) is added to water, the free and half-bound carbonic acids are removed and calcium and magnesium are precipitated, the former as a mono-carbonate and the latter as the hydroxide. The chemical reaction which takes place may be expressed as follows:

$$\underset{\text{Bicarbonate of calcium}}{Ca(HCO_3)_2} + \underset{\text{Calcium hydroxide (caustic lime)}}{Ca(OH)_2} = \underset{\text{Mono-carbonate of calcium}}{2CaCO_3} + \underset{\text{Water}}{2H_2O}$$

Not all of the calcium carbonate is removed from the water since, in the absence of carbonic acid, this salt is somewhat soluble (see Fig. 1).

In the case of magnesium a similar reaction results when caustic lime is added to the water. Sufficient lime must be used, however, to convert the mono-carbonate of magnesium into magnesium hydroxide, since the mono-carbonate of magnesium is fairly soluble while the hydroxide is practically insoluble.

The chemical reaction for the precipitation of magnesium is as follows:

$$\underset{\text{Bicarbonate of magnesium}}{Mg(HCO_3)_2} + 2\underset{\text{Caustic lime}}{Ca(OH)_2} = 2\underset{\text{Calcium carbonate}}{CaCO_3} + \underset{\text{magnesium hydroxide}}{Mg(OH)_2} + \underset{\text{water}}{2H_2O}$$

For the removal of the non-carbonate hardness, the sulphates or chlorides and nitrates must be converted into carbonates which, being insoluble, are precipitated. This is brought about by the addition of non-scale-forming soluble salts to the water (see Fig. 2). Sodium carbonate is employed usually for this purpose and reacts in the following manner:

$$\underset{\text{Calcium sulphate}}{CaSO_4} + \underset{\text{Sodium carbonate (soda ash)}}{Na_2CO_3} = \underset{\text{Calcium carbonate}}{CaCO_3} + \underset{\text{Sodium sulphate}}{Na_2SO_4}$$

$$\underset{\text{Magnesium sulphate}}{MgSO_4} + \underset{\text{Sodium carbonate}}{Na_2CO_3} = \underset{\text{Magnesium carbonate}}{MgCO_3} + \underset{\text{Sodium sulphate}}{Na_2SO_4}$$

On account of the solubility of the magnesium carbonate, a sufficient amount of caustic lime is added to the water to convert this salt into the hydroxide,

$$MgCO_3 + Ca(OH)_2 = Mg(OH)_2 + CaCO_3$$

Sodium hydroxide, NaOH (caustic soda) is used at times to precipitate magnesium sulphate, but it is not effective for the precipitation of calcium sulphate since calcium hydroxide is formed, which is quite soluble. When caustic soda is employed to soften water containing magnesium sulphate, the following reaction results:

$$MgSO_4 + 2NaOH = Na_2SO_4 + Mg(OH)_2$$

Caustic soda is somewhat preferable to soda ash for the removal of magnesium sulphate.

Sodium aluminate has been used recently as a softening reagent and is being adopted widely for this purpose. Barium salts (carbonate and hydrate) are employed at times as softening reagents and are preferable to sodium salts for the removal of non-carbonate hardness. The barium sulphate formed is insoluble and is precipitated from the water, whereas, when soda ash is used, sodium sulphate is formed, which is highly soluble, and concentrates in the boiler. At some plants barium is used in conjunction with lime. Barium salts are much more costly than sodium salts and are used generally only when difficulty is experienced from high concentration of sodium sulphate.

Chemical softeners are termed intermittent or continuous. There are many different designs of softeners on the market at the present time. They differ

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters." While logically coming under the heading of the present article, hot-process continuous softeners require more extensive treatment than is possible here. The fifth installment will be devoted entirely to them.

principally in construction details and in respect to the temperature at which the treatment takes place. Intermittent softeners are operated on the fill-and-draw plan, the system consisting usually of two or more tanks, one supplying soft water that has been previously treated, while the others are being filled and treated with the softening reagents. The units are operated generally on a definite cycle, which consists of filling the tank with raw water, adding the entire amounts of chemical in proportion to the amount of carbonate and non-carbonate hardness present in the water, agitating the water to insure thorough admixture and permitting the

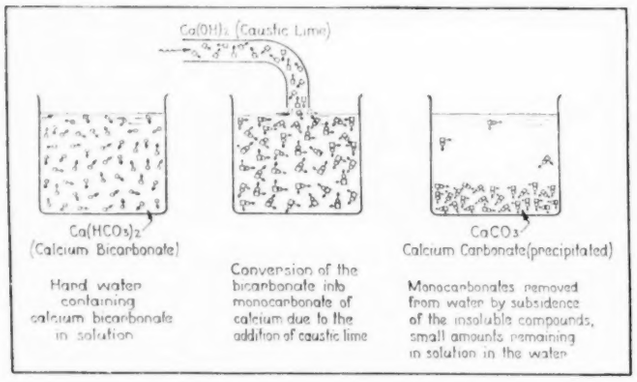

Ca(OH)2 (Caustic Lime)
Ca(HCO3)2
(Calcium Bicarbonate)
Hard water containing calcium bicarbonate in solution
Conversion of the bicarbonate into monocarbonate of calcium due to the addition of caustic lime
CaCO3
Calcium Carbonate(precipitated)
Monocarbonates removed from water by subsidence of the insoluble compounds, small amounts remaining in solution in the water

Fig. 1—Graphic illustration of what happens when caustic lime is added to remove temporary hardness

insoluble salts to precipitate while the water remains quiet. After a sufficient time has elapsed for settling of the precepitate, the soft water is drawn from the tank. The same procedure is followed with the other tank or tanks.

The usual design of intermittent softeners consists of two circular tanks equipped with inlet and outlet pipes, sewer connection for the removal of sludge, chemical dosing apparatus, etc. The outlet pipes are provided with swing joints, and the free end of the pipe is held slightly below the surface of the water by means of a float. In this way the softened water is always withdrawn from the surface. Many of the large installations are concrete and are similar in design to rapid sand filters, the precipitation basin taking the place of the coagulation and subsidence basin of the filtration system.

Filters may or may not be employed to clarify the effluent from intermittent softeners. Owing to the fact that settling takes place while the water is in a quiet state, fairly complete removal of suspended solids is effected without filtering. A number of factors influence the efficiency of these softeners. The temperature of the water, the time of reaction and settling, the accuracy of the proportioning of chemical and other conditions are of importance in producing proper softening action.

In a typical intermittent softening plant the water is delivered at either the top or bottom of the tank. A sufficient amount of caustic lime or soda ash to react with the non-carbonate and carbonate hardness is added to the water and the tank is then filled. The insoluble precipitate of lime and magnesium settles in the lower portion of the tank and after a given period of time when the majority of the hardening salts are precipitated, the soft water is drawn from the tank through the discharge pipe. Detention periods of from four to eight hours are employed, but it is often necessary to have a much longer time for efficient softening. The rate of reaction and settling of the precipitates is much slower in cold water than in warm or hot water.

Continuous Softeners

Continuous softeners are favored for the treatment of feed-water supplies at stationary plants especially when the feed water demand is constant, and many of the recently installed chemical softeners are of this form. Continuous softening, as the term indicates, softens the water while it flows through the apparatus. An outfit of this kind consists usually of a tank with a baffling arrangement, an apparatus for feeding the chemicals, means for agitation and compartments for the chemical reaction and settling of the precipitate. The water is treated with the chemicals as it enters the apparatus and the dose is proportioned to the volume and hardness of the water. Provision is made usually to agitate the water so that there will be an intimate mixture of the chemical and the water.

The untreated water enters the softener usually at the top of the apparatus, flows downward in one compartment of the tank where the reaction takes place and then upward in another compartment which serves as the subsidence chamber. The softened and partly clarified water is discharged from near the top of the unit. Filters of sand, non-silicious material or excelsior are employed generally to remove the finely divided precipitate that has not settled in the softener.

In Fig. 3 is shown one type of continuous softener, equipped with the chemical mixing and feeding device on top of the tank and the filter on the same level as the bottom of the softener. In this unit the raw water enters the mixing chamber *E* through the raw-water

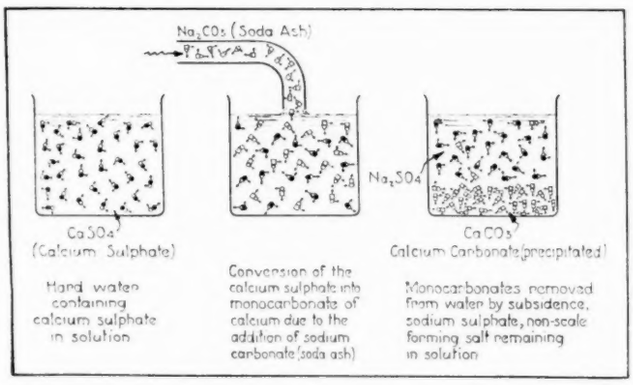

Na2CO3 (Soda Ash)
CaSO4
(Calcium Sulphate)
Hard water containing calcium sulphate in solution
Conversion of the calcium sulphate into monocarbonate of calcium due to the addition of sodium carbonate(soda ash)
Na2SO4
CaCO3
Calcium Carbonate(precipitated)
Monocarbonates removed from water by subsidence, sodium sulphate, non-scale forming salt remaining in solution

Fig. 2—What happens when sodium carbonate (soda ash) is added to remove non-carbonate hardness

pipe *A*. The volume of water is controlled by a float control device marked *H*. The measured amount of chemical is fed into the water as it enters the mixing or reaction chamber *E*. A whirling motion is imparted to the water by the direction of flow of the incoming water. The water is discharged at the bottom of the reaction chamber and flows upward slowly while the precipitated calcium and magnesium settle as sludge in the bottom of the sedimentation tank.

Soft water is discharged from the apparatus through the pipe *F* and passes through the pressure filters which remove the solids that are not deposited in the sedi-

mentation tank. Sludge that settles in the softener is removed from time to time by the sludge line *P*. The pressure filter is back-washed when necessary. The rate of flow of water through the apparatus controls automatically the amount of chemical solution applied to the raw water.

The softening apparatus shown in Fig. 4 has a reaction chamber and sedimentation chamber in the same

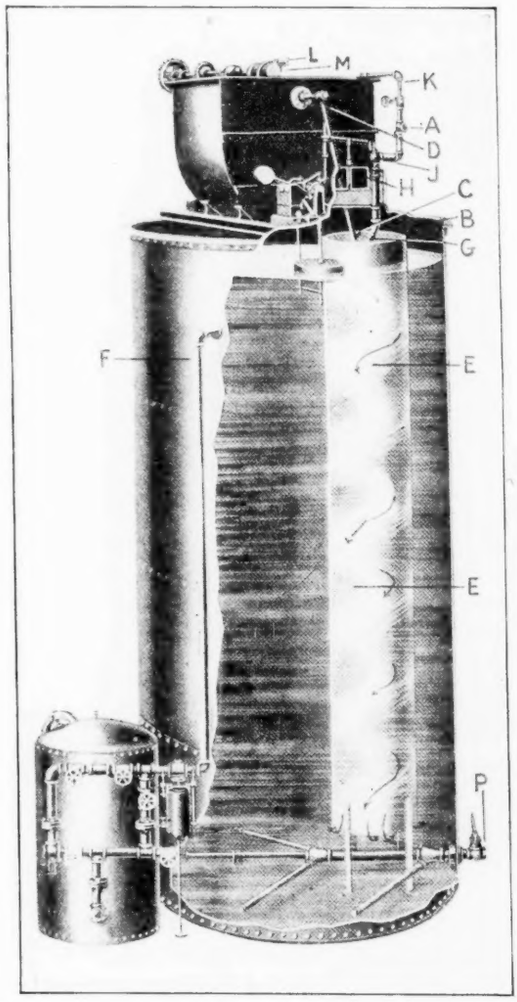


Fig. 3—Continuous chemical softener treating cold water (International Filter Company)

tank and the flow of water and chemicals is controlled automatically. The incoming water enters the apparatus at the top of the unit through a pipe *B* by means of which it is delivered to a waterwheel which develops sufficient power to operate the device for the agitation of the chemical solution. This solution is saturated on the ground level and the chemicals are raised to the top of the tank, where they are added to the raw water as it discharges into the reaction chamber. The treated water rises slowly in the settling compartment where the insoluble calcium and magnesium salts are precipitated. The sludge is removed from the tank through the sludge-collecting system in the bottom of the tanks and discharged to the sewer.

Since the operation of continuous softeners depends upon the application of the chemical reagents in proportion to the rate of flow of water through the apparatus, much greater ingenuity has been exercised by designers of this form of equipment than in the intermittent type. There are numerous softeners employing a number of different arrangements for regulating the quantities of chemicals used for mixing.

The essential features of a continuous chemical softener are as follows:

a. The mixing device for the preparation of the chemical.
b. The chemical dosing apparatus for proportioning the chemical or chemicals used.
c. The reaction or mixing chamber.
d. The settling compartment.
e. The filter.

Solutions of sodium salts are easily made and can be kept fairly uniform in strength by slight agitation.

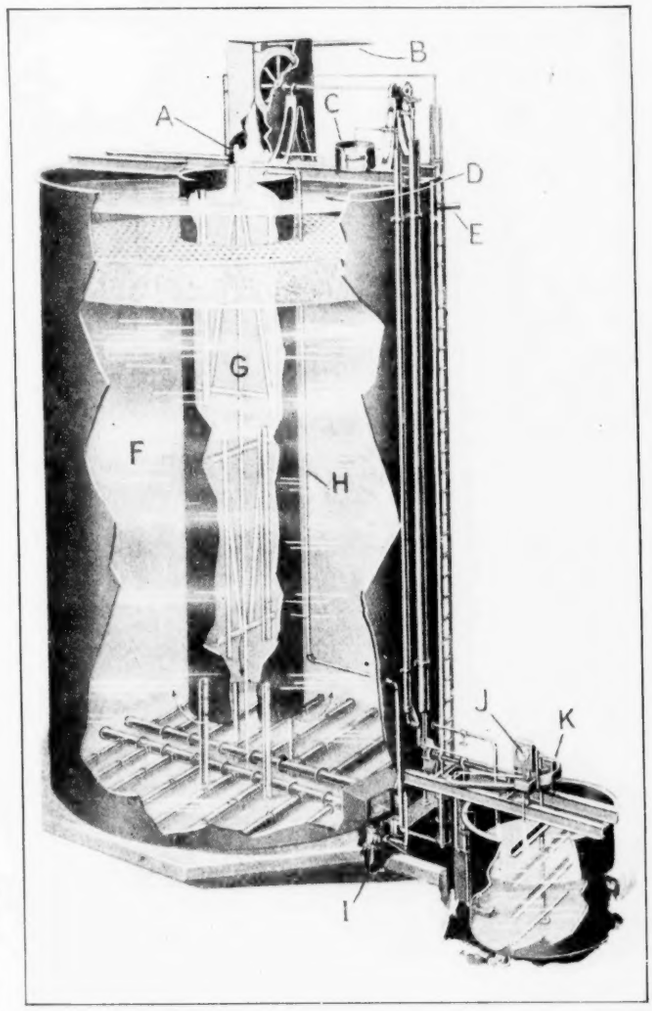


Fig. 4—Chemical softener treating cold water (Booth)

A—Sutro weir; B—Inlet; C—Float tank; D—Soft water storage; E—Outlet; F—Settling space; G—Softening plant; H—Chemical supply pipe; I—Sludge valve; J—Recorder; K—Chemical regulator.

It is far more difficult to prepare a solution of milk of lime, since the hydrate of lime is only slightly soluble. To keep this chemical mixture of uniform composition, the solution must be agitated constantly at a rate sufficiently high to preclude the settling of solids from the mixture or stratification of the liquor. Other things being equal, the efficiency of the softening apparatus

will be proportional to the uniformity of lime solution added to the water. The fluctuations in the quality of water from some softeners is due largely to the variation in the strength of the lime solution used. Manufacturers have realized the necessity of obtaining milk of lime and other chemical solutions of constant strength, and efficient chemical agitators for this purpose are now obtainable. The use of dry-feeding chemical devices has been developed within the last few years, and a number of different appliances of this type are now on the market.

Next to the application of chemicals the mixing or reaction chamber is of the greatest importance. The chemical should be thoroughly and efficiently mixed with the raw water. If good mixing is not accomplished in the reacting chamber, there will result a loss of

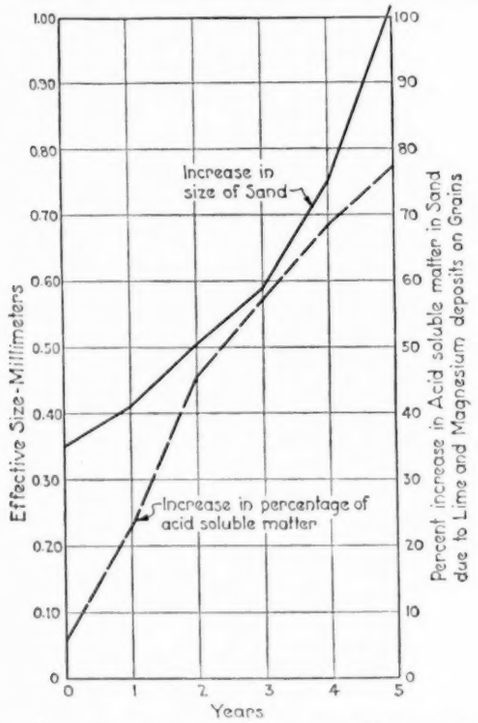


Fig. 5—Growth of sand grains in a filter used with a municipal lime-soda softener

lime and a low softening efficiency. Practically all types of cold chemical softeners provide some means of mixing. This may be accomplished by imparting a whirling motion to the water as it enters the reaction chamber, by means of baffles or by mechanical agitation. The latter form of mixing is usually the most efficient method, but entails the use of power-driven appliances, thus increasing the maintenance and operating costs.

The time required for complete reaction varies from a few hours to several days. It is usually not economically possible to build softeners sufficiently large to effect complete reaction at all times.

The upward rate of flow of the treated water through the settling compartment should be sufficiently slow so as not to carry up the finely divided precipitant. The vertical rise of the water in continuous softeners varies with the size and depth of the tank. It is common practice to maintain the rate of rise at from three to four feet per hour.

The settling compartment should be provided with a sewer of sufficient size to withdraw the settled sludge from the tank quickly. Some subsidence tanks have hopper bottoms and others have flat bottoms. Where the latter form is used, a sludge-collecting system, usually a system of perforated pipes, is employed. Sludge lines are provided generally with quick-opening valves. At times provision is made for returning some of the sludge to softeners. This procedure has some advantage, since with some water it reduces the cost of the reagent and appears to effect more rapid coagulation and settling of the precipitated salts.

The use of filters in connection with the operation of either hot or cold continuous softeners is now generally considered essential. Pressure filters are used mostly for this purpose, although rapid sand gravity filters are used at times with softeners treating cold water. Excelsior filters have been used to some extent in the past, but are seldom used now excepting for special reasons where silicious filter material is not desirable. Pressure filters used for this purpose are in all respects the same as those used for other water-purification projects.

The principal difficulty encountered in the operation of sand filters used in connection with softeners treating cold water is the incrustation of the sand grains. The majority of the solids carried over from softeners are removed when the filter is back-washed, but some calcium and magnesium may adhere to sand grains, coating them over with deposits which are not removed when the filter sand is washed. These incrustations cause the sand grains to increase in size and at times result in cementing the sand into patches, even though the back-washing of the filter has been regularly and efficiently carried on. This is illustrated by Fig. 6.

The adaptability of continuous or intermittent precipitation softeners should be considered with reference to the relative merits of both forms of treatment with respect to local operating conditions. Where there is a steady demand for water, the continuous type is preferable unless storage is provided for soft water. As a rule, intermittent softeners permit of more accurate dosing with chemicals, since the entire charge of the softening reagent is added to the water at one time in proportion to the volume and hardness of the water supply. Better subsidence is effected usually in intermittent than in continuous units, there are no currents (other than diffusion or convection currents) to overcome the settling of the suspended solids. Continuous softeners are preferred, since the apparatus is much smaller, requiring one tank only. Continuous units require more detailed attention than intermittent softeners, but they are usually favored because they are more flexible in operation.

Cost of Treatment

The cost of operation of continuous or intermittent softeners treating cold water fluctuates greatly. The size, the type and the location of the plant, the efficiency of the unit and the character of the untreated supply affect the treatment cost markedly. It is difficult to specify cost figures without details of the specific installation. Softening, including capital and operation costs, will fluctuate from about two cents to nine or ten cents per one thousand gallons of water treated. The saving resulting from the removal of scale-forming solids by any form of treatment is warranted if there are any appreciable amounts of these substances in the water.

Modern Methods in

Coal and Ash Handling

By W. W. SAYERS
Chief Engineer, Link-Belt Company, Chicago

METHODS of bringing fuel to the furnace and taking away the ash have kept pace with developments in steam generating equipment. In this, the first of five articles on the subject, the author traces the progress that has been made in the field and emphasizes the importance of the fuel handling problem.

IT IS but natural that power-house methods have changed radically during the course of progress from the small hand-fired boiler, which was considered big not so many years ago, to the large boiler of today, with 30,000 sq.ft. of surface, equipped for automatic firing. The 1,000-sq.ft. boiler was considered big because it was measured by the yardstick of manual labor. Its fuel was unloaded from the car and transferred to the boiler and shoveled in by hand. The ash was removed in the same way. The large unit of today, with its coal mechanically unloaded, placed in ground or overhead storage and fed to the stokers automatically, is beyond the realm of manual labor.

Progress in this field is all the more striking when it is considered that in spite of labor costing from five to eight times as much and coal four or five times as high, the cost per unit of steam delivered to the prime mover is less than ever. This is a plain indication that modern methods and equipment for handling coal and ash have been developed to meet the new economic conditions and requirements.

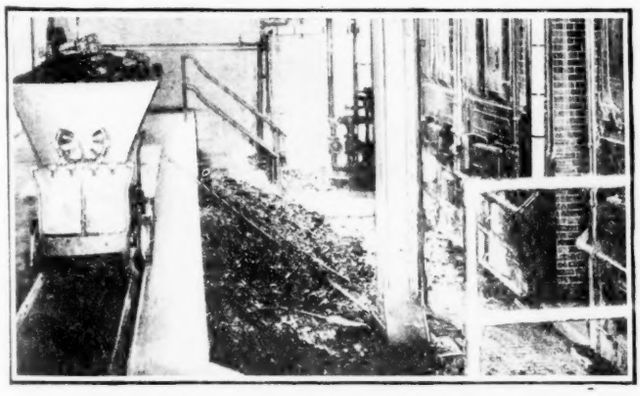


Fig. 1—First advance over the wheelbarrow

Methods of bringing fuel to the furnace and taking away the ash, have had to keep pace with the demands created by the larger furnaces. It would be ridiculous to attempt to handfire one of the modern boilers, for today the automatic stoker is taxed to the limit, and with the economic trend toward even more rapid combustion, increasing quantities of fuel must be handled with minimum labor.

Progress from the small to the large plant has shown plainly that it is just as essential to use proper methods for bringing the fuel to the furnace and taking away the ash, as it is to have the best and most modern type of furnace to burn it. In the past the engineer and owner were inclined to belittle the importance of the coal- and ash-handling requirements. They felt it necessary always to provide reserve boilers, pumps, generators, etc., and no expense was considered too great to insure uninterrupted service so far as this equipment was concerned, but the conveying and elevating machinery was looked upon as a more or less necessary evil, to be selected with the least possible expenditure.

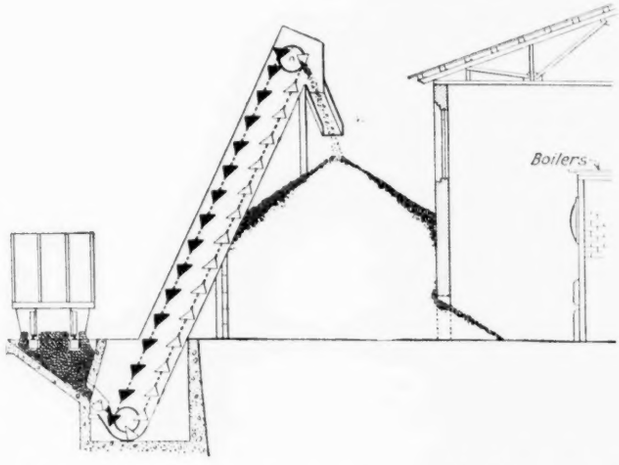


Fig. 2—One method of conveying coal to boiler house

Reserve Capacity Neglected

To keep the investment low in this part of the equipment, rarely was it made more than just large enough to meet the requirements, without thought of reserve units or reserve capacity. A common mistake was to overlook the importance of sufficient overhead bunker storage, and much of the equipment was chosen as if no delay or interruption could ever happen from one or more of the elements wearing out.

Power-plant engineers now generally realize that the steam turbine, boiler, or any of the equipment cannot function properly without suitable coal- and ash-handling equipment, for the complete power plant as a unit is no stronger than its weakest link. While in the past the engineer concentrated upon the turbine, generator and boiler, today he does not overlook the pos-

sibility of effecting economies in the preparation, storing and handling of the coal, as well as in the removal of the ash. Nor does he neglect to safeguard against possible interruptions, just as he protects the boiler or the turbine.

Technical literature in general is still behind the

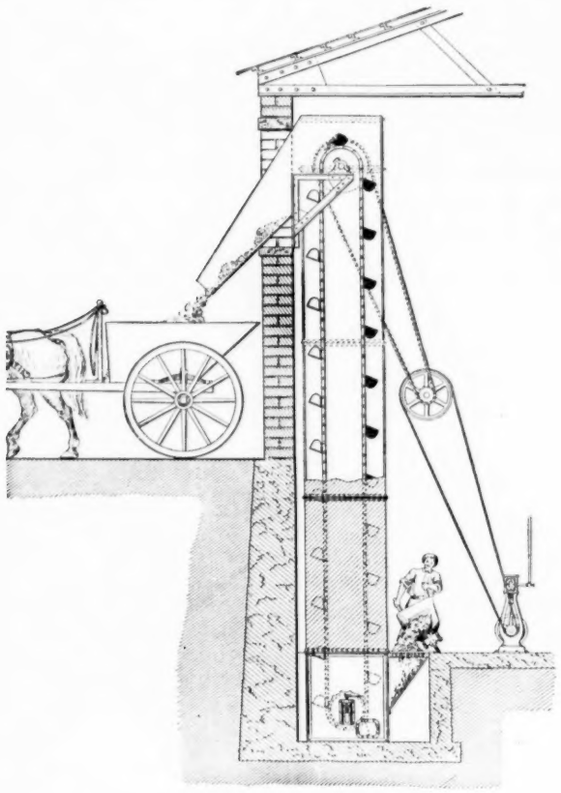


Fig. 3—Bucket elevator for ashes

times in this respect. While it abounds in volumes devoted to generating steam and electricity, little can be found regarding the handling and the preparation of fuel, notwithstanding the fact that the cost of improper handling cannot be made up by slight increases in boiler efficiency. In itself fuel handling is a problem

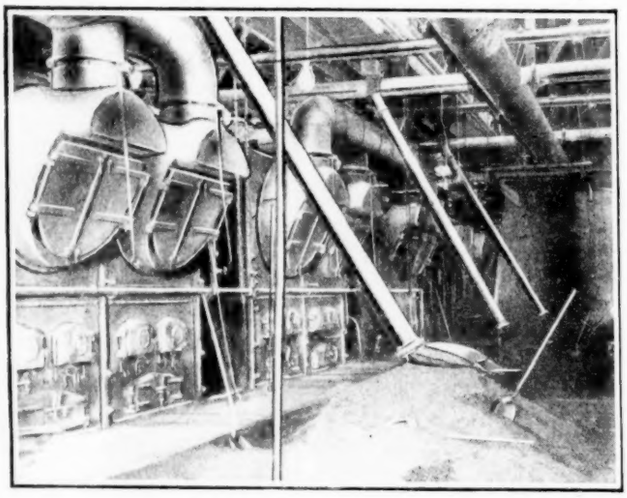


Fig. 4—Overhead bunkers placing coal on floor for hand firing

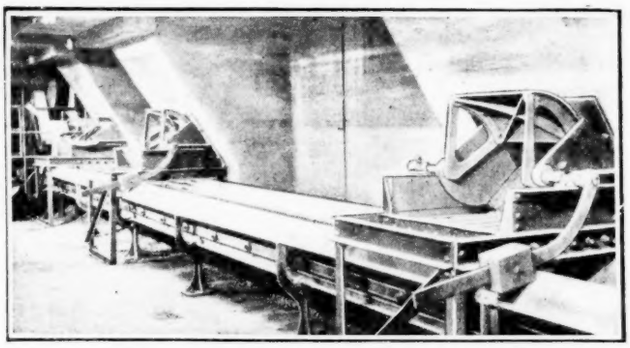


Fig. 5—Overlapping pivoted bucket carrier

of importance, and the general viewpoint must be revised to this conception.

In the early days the wheelbarrow served its purpose, but soon became inadequate for bringing the coal from the pile to the boiler; also labor became scarce and less reliable. Less costly methods having greater capacity were needed, so the wheelbarrow had to give way to various mechanical contrivances.

One of the first advancements was to transfer the coal from storage to the boiler-room floor by means of small industrial cars, as in Fig. 1, the coal being shoveled from the floor to the grates. Each industrial car held as much as several wheelbarrows, thus reducing the number of trips and the amount of labor. This marked the first step in labor-saving devices for coal handling.

Conditions soon changed. The small hand-pushed car was replaced in many plants by the bucket elevator or scraper conveyor, which elevated, transferred and delivered the coal as received from wagons or railroad cars, to piles on the floor in front of each boiler, as shown in

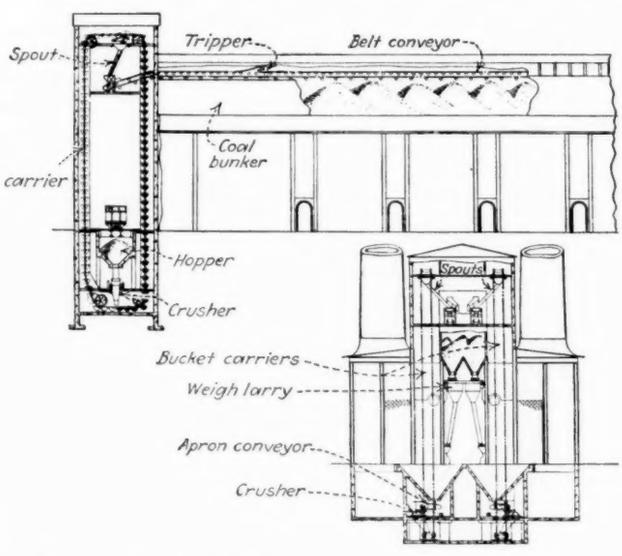


Fig. 6—Pivoted bucket carrier and belt conveyor combination

Figs. 2 and 4. The boilers became larger and greater in number so that the space on the boiler-room floor was insufficient for coal storage piles. This situation was overcome by the use of small overhead bunkers, which were the forerunners of the large bunkers now used. They were located in front of the boilers, and

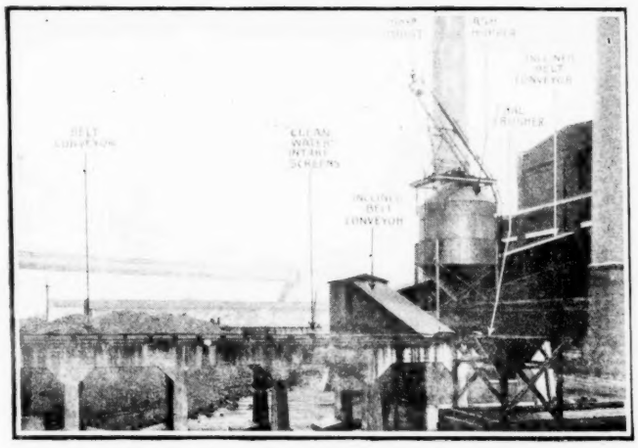


Fig. 7—From storage to plant by inclined belt conveyors

coal was withdrawn as needed in small piles on the floor, from which it was hand-fired to the grates.

As boiler plants increased in size, many firemen were required. They needed considerable skill to secure the maximum quantity of steam with minimum pounds of coal. Being human, they required supervision and careful training. Every time the firedoor was opened, cold air rushed in to chill the hot furnaces, and large quantities of unburned gases were belched from the chimney in the form of black smoke, a menace to the community as well as a considerable loss of fuel.

Even when skilled firemen were available, the labor costs were high. Something had to be done. A change of methods was necessary, or the growth of the boilers and further economy in operation were checked. It seemed impossible at that time to replace hand stoking, and just as it looked as if the maximum in boiler size had been reached, mechanical stoking began to be applied.

Mechanical Stokers Introduced

The mechanical stoker revolutionized the power plant, its influence extending to every channel of routine practice. In the first place the mechanical stoker required coal of small size, necessitating the installation of crushers at practically every plant to reduce the large lumps to small size. This added another unit to which the lumpy coal must be delivered and from which it had to be removed on its way from truck or car to the overhead bunker. Since this development the number of elements of the coal-handling system have not materially increased or decreased, but their capacities and types have been changed to keep pace with the conditions and the times.

Important imprints made by the introduction of the mechanical stoker on the boiler plant were in the shape of the building required for the overhead feed and the larger boilers it made possible. In the early days the boiler room usually was in a long narrow building made to accommodate one or two rows of boilers. Today, for practically the same steam generating capacity, the building is comparatively short and high. Now it is not uncommon for one boiler to equal in capacity from ten to thirty of the old ones. The larger boiler with forced- and induced-draft instead of natural draft, requires great quantities of coal burned at maximum rate. To accomplish this, large quantities of fuel must be stored above the stoker, available for any power demand. The modern boiler house is notable for the absence of men, dirt, noise and other confusions which were previously considered a necessity. Literally, one must hunt for the coal- and ash-handling apparatus and operation. The coal and ash, like bread or breakfast food, is "untouched by human hands." These changed conditions must be accredited to the mechanical stoker.

Ash-Conveyor Development

It followed that as larger quantities of coal were burned, the quantity of ash to be taken care of, increased in proportion. Consideration had to be given its disposal. The then existing types of elevators and conveyors were not suitable for handling such hot abrasive materials as ash. For the smaller plants, elevators equipped with wear-resisting buckets and chains were built similar to Fig. 3. The ash was brought to the elevators in wheelbarrows. Subsequently, these were superseded by the overlapping pivoted-bucket carrier, Fig. 5, which served the manifold purpose of elevating, conveying and discharging the coal from the crusher to the overhead coal bunker, as well as receiving the ash as raked or fed from pits under the stokers, conveying, elevating and discharging it into the overhead ash storage, to be withdrawn to railroad cars or trucks for disposal. Following closely after the introduction of the mechanical stoker, the pivoted-bucket carrier has maintained its position as an economical unit for handling both coal and ashes.

The belt conveyor is used commonly for conveying and distributing coal to overhead bunkers, from track hoppers or from elevating mediums, such as bucket elevators, gravity discharge conveyors, skip hoists, pivoted-bucket carriers, and hoisting units employing

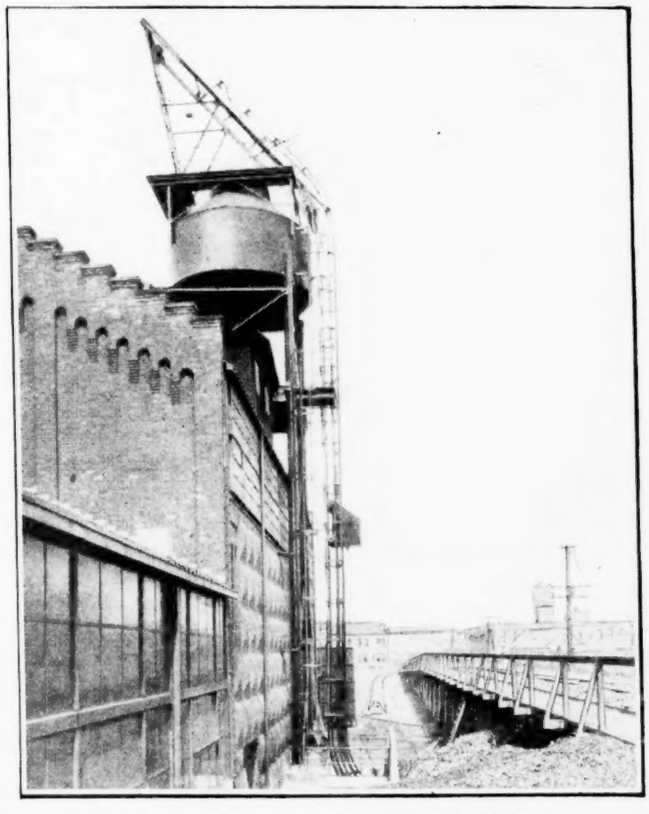


Fig. 8—Typical skip-hoist installation

grab buckets. Fig. 6 shows one of these combinations. The belt conveyor also is used as the elevating unit direct from the track hopper, where the elevation is not too great, and where sufficient space is available, as in Fig. 7.

Numerous other types of hoisting and elevating equipment are used to meet particular requirements. For example, the skip hoist is used frequently for elevating coal. It is well adapted for that purpose when the lift is high. The coal is discharged into a single large overhead bin, Fig. 8, or to a belt conveyor for distributing it to overhead bunkers. Also it is well suited for handling ash where the quantities are large

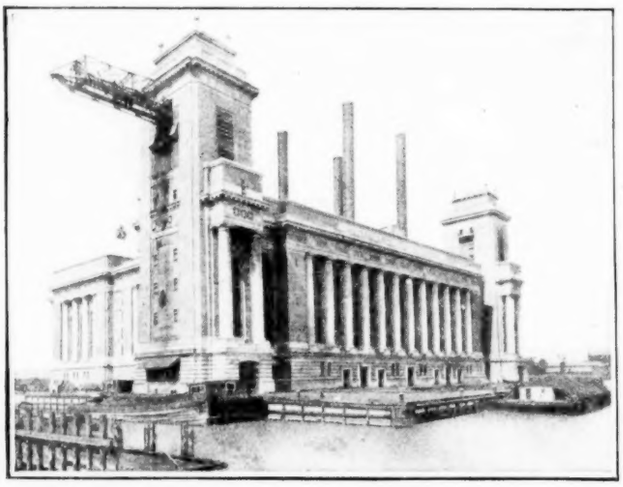


Fig. 9—Unloading tower for water-borne coal

or conditions are such as to require a separate unit for that purpose, and where a single unit, such as the pivoted-bucket carrier, will not advantageously serve both the coal and the ash.

Water-borne coal received in ships or barges is unloaded usually by a grab bucket, operated by a locomotive crane, bridge tramway or perhaps by an unloading tower such as is shown in Fig. 9. After being hoisted it is discharged into a hopper, crushed and distributed to overhead bunkers by belt conveyors or small cars operated by a traveling cable.

There are many variations and combinations of the different types of equipment briefly outlined. The purpose of this article has been to give a mental picture of the conditions that obtained prior to those of today and to show how the economic trend has influenced the change in the equipment. In order that the reader may secure a better understanding of what equipment is available and its best application to typical conditions, different types of equipment will be reviewed in succeeding articles.

The only form of brine cooler now used to any extent is the shell-and-tube design. Usual values for heat transfer in such brine coolers have been low, from 90 to 100 B.t.u., but no doubt greater values can be obtained if care in operation is taken and the amount of liquid fed into the cooler great enough so that, with the use of some trap or separator, the evaporator surfaces may be kept flooded without continuous danger to the compressor.

Financial Obstacles to Hydro-Electric Development in France*

By R. H. Andrews†

A year ago the Syndicate of Hydraulic Power noted the rapid growth of electric power demand in France, the increasing difficulty encountered in keeping power-generating facilities up to the demand, and the practical impossibility of developing water-power sites located within reach of their transmission systems or distribution points.

The situation is worse at the present time. The power demand is rising at the same rate, and many electrochemical and electrometallurgical companies have been unable to satisfy the domestic and foreign demands for their products, for lack of electrical energy. Yet, in spite of the increasing need of power, hydro-electric development has been marking time in France. Not only does the realization of the principal projects of the Rhône, the Rhine and the Dordogne basins appear more and more distant, but many smaller developments intended to cover immediate power requirements have been deferred or abandoned.

Since 1918, partly under the impulse of military needs, there have been developed 240,000 kw. of water power and 90,000 kw. actually under construction may be completed before Jan. 1, 1928. There remain 331,000 kw., representing the total of the developments authorized, for which concessions were granted two or three years ago, and on which construction has not even been started, or has been abandoned before completion, or is progressing at such a rate that the completion of the project appears more and more uncertain as the financial situation grows darker. If the great projects of the Rhône, Rhine and Dordogne be added to these 331,000 kw., the total of the hydro-electric developments in suspense in France exceeds one million kilowatts.

Capital Diverted from Hydro-Electric Projects

The causes of these conditions are evident. Hydro-electric developments require the tying up of large amounts of capital for long periods. Undoubtedly, available capital is not lacking in France. In 1925 bank deposits increased from 25 billion francs in January to 35 billion francs in December. At the end of 1925 the excess of savings-bank deposits over withdrawals amounted to 14 billions, as compared to 12 billions in 1924. But this capital is used preferably for short- rather than long-term investments, in the face of the menace of further depreciation of the franc.

Under these conditions it is not surprising that the increasing demand for electrical energy should be met by steam-plant construction, which costs one-third as much and takes considerably less time than hydro-electric construction. Statistics are not available covering steam-plant construction in recent years, but the proportion of auxiliary steam-plant capacity compared to the total capacity of hydro-electric systems has increased from 18 per cent in 1918 to 43 per cent in 1923.

The gravity of this situation has prompted the government to file a bill to assist hydro-electric development by means of subsidies or low-interest loans, the necessary funds to be provided by a tax of not more than 5 per cent on the sales price of electricity for lighting.

*Abstract of report by M. Tochon to Syndicate of Hydraulic Power.

†Paris Representative of *Power*.

Turning Down the Gas Made the Fire Hotter

"IF YOU want more heat turn up the gas." It sounds sensible and serves well enough as a rule of thumb for cooks and others, but like most rules of thumb, falls down now and then in an emergency. Cases are on record where the pot boiled harder when the gas was turned down. What is more, such cases do no violence to the established principles of combustion.

There comes to mind a recent example in which the "pot" was a battery of boilers fired by blast-furnace gas. One day for no apparent reason steam pressure began to fall. The demand was normal, gas pressure was up, and the gas showed no falling off in quality. Under the circumstances the foreman naturally jumped to the conclusion that more gas was needed. But when he turned on more gas, conditions became worse rather than better. It then occurred to him that the cause of the trouble might be too much gas instead of too little. Remembering his principles of combustion, he reasoned that excess gas over the theoretical mixture would act exactly like excess air in diluting the heat produced and lowering furnace temperature. This proved to be the case; when the gas flow was cut down, the steam pressure rose.

The incident is a nice illustration of the necessity of a knowledge of the fundamentals. Rules of thumb have a certain field of usefulness, but only the man who has mastered his fundamentals is fully equipped to handle the unexpected.

High- and Low-Pressure Boilers

IN a paper recently read before an association of public school officials, an engineer, in discussing the merits of low-pressure boilers for school heating systems, made several statements that were, to say the least, based on very shaky foundations.

It was stated that the furnaces of high-pressure boilers gave more trouble than do those of low-pressure boilers. If one will stop to consider the small temperature difference between two hundred pound and thirty pound steam, it will become obvious that there is no necessity for carrying a much higher furnace temperature. It must be conceded, however, that the furnace temperatures of the high-pressure boiler are higher —this is not due to the higher steam temperature, but to the fact that high-pressure boilers are operated more efficiently. The average attendant of a low-pressure installation is notoriously a poor fireman—he either carries too heavy a fuel bed with the consequent low combustion temperature or admits too much excess air by his uncertain firing methods. Operated properly to obtain even reasonable efficiency, there is but little furnace-temperature difference between the two types of boilers.

The real reason that low-pressure installations do have but minor furnace troubles is traceable to the overboilering of the plant. Instead of operating even at normal ratings, it is customary to find such a boiler evaporating less than two pounds of steam per square foot of heating surface. The purchaser can choose either high efficiency and some furnace troubles or a high capital investment in excess boiler surface, low efficiency and negligible furnace repairs. That the latter are too frequently chosen is a reflection upon the owner's and architect's engineering education.

The third advantage mentioned, of permitting the employment of less skilled firemen, is actually a disadvantage, for the saving in firemen's pay is insignificant beside the extra fuel cost entailed.

Of course the difference in the explosive ability of a high-pressure and a low-pressure boiler, upon which stress was laid, is but slight. The damage two low-pressure boilers can do is far more than that expected of one high-pressure unit of half the total water capacity.

It is quite possible that low-pressure boilers are better suited for the Minneapolis public schools, as the engineer stated in his paper, but the reasons surely embody sounder engineering than was given in the paper.

Keep Them All Alike

SHALL new equipment duplicate the old? If the old is satisfactory, why not?

The business of the power-plant engineer is to produce power at the lowest cost attainable. He is not charged with the accumulation of a museum of plant equipment.

It is worth good money for a plant to have like pieces of equipment actually identical, assuming, of course, that they serve acceptably. The money saving is twofold. First, the proportionate value of spare parts held in stock may be considerably reduced as the number of identical units increases. Second, the plant men will become more thoroughly familiar with the equipment. The operator will use it more uniformly, and under proper supervision this can easily be made to yield more intelligent and less damaging use. The maintenance man will be more sure of what to expect and can have the right parts and tools at hand. Repairs will be expedited and better. Now and then it happens that with diverse equipment, spare parts held for years as a safeguard against a serious shutdown are drawn from stock only to be found not to fit the individual machine under repair. This costs money in delay or in special machine-shop work.

The fact that a given unit, whether a small valve or a large turbine-generator, is giving satisfactory service in a plant is a good reason why new units should be duplicates of the old. Distinct superiority alone can justify "mixing the breed." The salesman who urges the use

of his device because it has not been tried in the customer's plant is citing an excellent reason why no such trial should be made.

If present equipment does not serve well enough, then any alert operating engineer will of course try others, but he does this for his own good. Having met the needs of his plant, he is under no obligation to try the products of other manufacturers, so long as the results are not published or, if published, are carefully restricted in their application.

Keep the plant uniform and consistent. It looks better and is better than it looks.

Over against this, the engineer must never forget that there are two kinds of condemnation for any device —one that it fails to deliver as desired due to its own defects, the other that it is obsolete due to the superior merits of something new. Every plant should be laid out with room to take advantage of the possibilities of new equipment, and every engineer should keep his mind open to new ideas. In some cases the new is so much better than the old that it will pay not only to use the new unit on new work, but even to replace old equipment despite its satisfactory operation as judged by old standards.

The balance between a beautifully consistent plant, built according to the original pattern with serene ignorance of the advancement of the art, and a plant embodying every new inspiration of the inventor, is not easy. The engineer must be both alert and conservative. That is his job. There is no dodging it if he expects to attain and maintain a high standing in his profession.

Providing Peak-Load Capacity

WATER-POWER plant installations are in general considered developments requiring much higher capital investment than steam plants, so much so that the increased fixed charges on the water-power development largely offset the higher operating charges of the fuel-burning steam plants. The lower fixed charges of the steam installation have made it the object of more favorable consideration for peak-load plants on many systems. However, the article in this issue, "Automatic Hydro-Electric Plant Designed for Peak-Load Service," which describes an installation to operate at a load factor of less than fifteen per cent, shows that under certain conditions peak-load hydro power may be produced cheaper than in a steam plant.

In any hydro-electric plant there are certain investments that must be made, such as for lands that are flooded, changes in highways and bridges, and construction of dams and waterways, before the plant can be built for operation on any kind of a load. After these investments have been made, practically the only other costs for the development are for the plant and its machinery. The cost of a water-power installation, for the plant and its machinery, will vary with the head and other conditions incident to the site, but for a head of one hundred feet the cost will probably not be more than one-half as much as that for the same capacity in a steam plant. If the hydraulic plant can be justified on a competitive basis with a steam plant and system load factor, then it can, if sufficient storage is available at the plant, provide peak-load capacity at less cost than a steam plant. If a plant was designed to operate at eighty per cent load factor and the cost of the plant and machinery was one-third of the total cost, increasing the capacity of the plant to the point where it could operate at twenty per cent load factor would decrease the investment per unit capacity to one-half that for the high load-factor plant.

Peak-load power is always high cost power no matter how it may be produced, and the shorter the duration of the peak the higher the cost per kilowatt-hour, on account of the higher stand-by charges. For this reason when water-power plants are used on peak-load service, the power is not produced at rates normally associated with water-power developments, but at four or five times these rates or even higher.

There are many factors that influence this whole problem. For the water-power plant to be satisfactory for peak-load service, there must be a certain amount of storage capacity at the plant and a regulated flow of the river that will insure water being available for operating the plant. The distance of the plant from load centers will also have an influence on the economics of the development. If the fuel costs at the steam plant are high, it will be more favorable to the water-power plant than if they are low. Therefore, no hard or fast rule can be laid down to govern such installations; each must be decided by giving proper weight to each economic factor. However, the plant mentioned is a good example of how far it may pay to go in placing peak-load capacity in a water-power plant if other conditions are favorable.

Data Needed on Boiler-Room Performance

COMPLAINT is frequently heard that a dearth of information exists on the performance of industrial power plants; that is, data that would be valuable for comparative purposes.

Similar data in very complete form are available with regard to central stations, but there the problem is much simpler. Not only is there a single product, kilowatt-hours, but as a result of public service regulation, a fairly uniform system of records is followed. With the industrial power plant, however, byproduct services such as process steam at various pressures, and steam for heating, also in some cases mechanical drive, complicate the problem. Moreover, there is no common yardstick by which these may be measured. Add to this an inadequacy of instruments for metering these various services and the situation becomes involved.

While the records of many plants are sufficient unto their own needs, they are generally useless for comparison with the performance of other plants unless the operating conditions be similar. Of course, within a given industry the cost of power as a component of the finished product is often illuminating, but the engineer wants to know more than this.

There is, however, a common ground, covering part of the plant operation, namely, the cost per thousand pounds of steam produced or the evaporation per pound of coal, due allowances being made for steam pressure and heat value of the coal. This is an index of the operating efficiency and should be obtainable where the feed water is measured and the coal weighed. There is no excuse for not knowing these two quantities.

Power would welcome an opportunity to serve as the medium of exchange for such information concerning readers' plants. Who will start off?

Practical Ideas From Practical Men

Location of Lineshaft Drive

The location of the lineshaft driving pulley with respect to the length of the shaft has much to do with the size of the shaft and therefore the size of bearings and hangers. Of course the location of the prime mover determines the location of the driving pulley, but where the electric motor is used as the prime mover the location is more or less flexible and the motor can be placed in the most advantageous position. A general

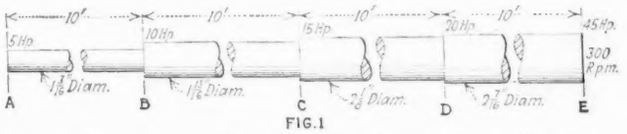


FIG. 1

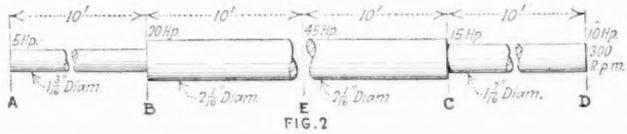


FIG. 2

Size of lineshaft required depends upon arrangement of shaft and machine drives

observation of many shops indicates that this subject is given scant consideration, yet by a careful study of conditions a considerable saving can be made in the initial investment.

To take an illustrative example, consider Fig. 1, which shows diagramatically a lineshaft having the driving pulley at *E* at one end of the shaft. We have machine driving pulleys at *A*, *B*, *C* and *D*, each consuming the horsepower indicated. The total horsepower is 45, and we will assume that this will all be in use at one time. Taking the Jones & Laughlin Steel Co.'s formula for horsepower capacity of cold-rolled shafting, $HP = d^3R \div 100$, and solving this for d we have $d = \sqrt[3]{\frac{100\,HP}{R}}$, in which d = the diameter of shaft; HP = horsepower transmitted; R = revolutions per minute of shaft = 300 in the case assumed.

Solving for d for the various sections of shafting, each of which is assumed to be 10 ft. in length, we have:

	Lb.
Section A to B = 1 3/16 in. total weight	37.66
Section B to C = 1 7/16 in. total weight	87.73
Section C to D = 2 in. total weight	120.60
Section D to E = 2 1/16 in. total weight	158.70
Total weight	404.69

In Fig. 2 is shown the center drive with the same length of shafting and the same horsepower machines changed around slightly to balance the load on either side of the main pulley. Using the same formula and solving for d in each case we have:

Section A to B = 1 3/16 in. total weight	37.66
Section B to E = 2 1/16 in. total weight	113.60
Section D to C = 1 5/16 in. total weight	55.18
Section S to E = 2 1/16 in. total weight	113.60
Total weight	319.64

The weight of shafting in the second layout is 21 per cent less than in the first, showing a substantial saving.

There are other important savings to be made by driving from the center of the shaft instead of from the end.

1. The center driven shaft will not shift out of true as readily as the end driven shaft. The load is balanced on each side of the drive.

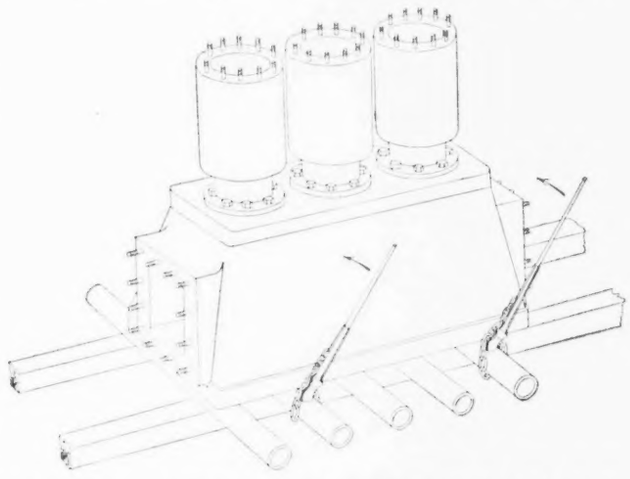
2. Bearings and hangers can be made lighter in comparison with the end drive. These elements are proportioned with the diameter of the shaft and any saving in shaft diameter will be reflected in a corresponding saving in these elements.

3. It allows for a more uniform distribution of the load. If the character of the machines on the drive is such that one of them takes the bulk of the power, the drive pulley should be near the maximum power take-off. Obviously, if this heavier drive is near the end, then the main driving pulley should also be near the end, the lighter machines being distributed along the shaft in the most logical arrangement. Local conditions must govern in each installation. C. C. HERMANN.

Moline, Ill.

Moving Heavy Loads Easily

The accompanying sketch shows an easy way to move heavy pieces of machinery by using large pipe rollers (wooden ones can be used the same way, but they will be roughened after a time) and applying a couple of



Load is moved by turning pipe rollers with chain tongs

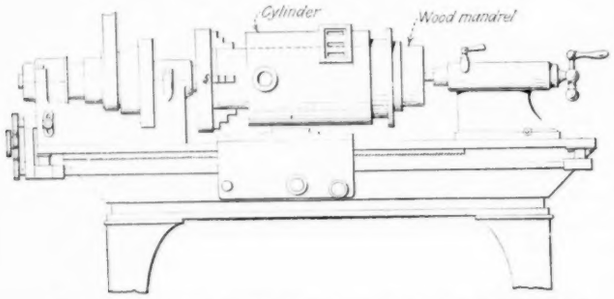
chain tongs to the ends of two rollers, one at each end of the load. In this way two or three men can move as much as half a dozen or more with pinch bars, and on a slight incline there is no trouble in holding the load with one tongs, while the other is getting a new grip. Two men can move a load of 25 tons without any overexertion. L. M. JOHNSON.

Sewickley, Pa.

Lapping a Small Semi-Diesel Engine Cylinder

The cylinder of a 60-hp. 4-cylinder semi-Diesel engine became badly scored on the liner walls, and it was decided to try and remove the scores by lapping.

Upon dismantling the engine, it was found that the scores were not deep, and that after lapping, the clearance between the piston and cylinder walls should not be too great to give satisfactory operation. A lathe



Lapping of the cylinder was done by revolving mandrel in lathe

was chosen large enough to carry the cylinder and a wood mandrel turned up to just fit in the cylinder. The mandrel was then smeared with oil and emery powder, and put through the cylinder and mounted in the lathe. The lathe was run at fairly high speed, the cylinder being held with the hands and great care was taken to hold the bore parallel with the mandrel. After some little time and care had been spent in performing the lapping operation the scores were removed.

This method of lapping will not be satisfactory if the cylinder liner is deeply scored or worn badly out of round. The engine in this case was a comparatively new one, and although too badly scored to continue running, the liner was not deeply scored or badly out of round. W. E. WARNER.

Shefford, Bedfordshire, England.

Mouse Caused Trouble in Waterwheel Governor

"Say!" the Boss said one morning, "better start down to Pinkumville and see what's wrong with that job. Read this letter and if you don't think they're peeved, come in later and ask me!" The governor, they said, wasn't worth a tinker's cuss, it never worked right from the start and we had better tear it out and put in something that would work if we ever expected to get the balance of the contract money. Outside of that, their letter indicated to the merest tyro that they had frothing at the mouth in a broad and general way.

So I got the next train out. The job was not very large, only two 1,000-kw. units, and had been erected by the power company's own staff who were understood to be capable men. When I got to the power house and the unit was put under the governor control, I was quite willing to admit that the governor was acting in a peculiar manner to say the least. It seesawed back and forth; now it opened the turbine gates wide, a few minutes later it threw off the whole load and the unit motored, all as if by an unseen hand.

Taking down the governor pump and piping showed everything proper except some dirt in the oil. Then the governor itself was taken apart and everything looked normal until I started to bolt the distributor valve on again, when a small piece of flesh covered with fur was discovered, which dropped out of the pilot valve chamber. Most distributor valves have oil ports that are rather crooked, and this was no exception. A hook was made on the end of a piece of copper wire and I started digging around. Presently a resistance was felt and on drawing the wire out it brought with it a somewhat mutilated mouse.

I asked if the pipes had been blow out with compressed air previous to being made up permanently, and the foreman was honest enough to admit that it had not been done. The mouse had crawled into the pipe while one end of it was open, probably during the night. When the pressure came on, he was forced up against the distributor valve until I dug him out.

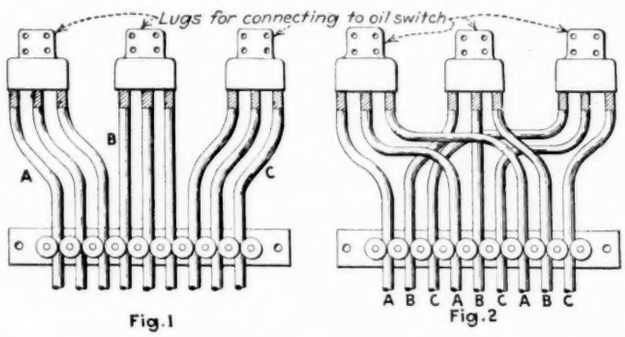
On another occasion I found that part of a leg from a pair of overalls had been stuffed into the end of a pipe to keep out any dirt and somehow somebody forgot to remove it before making up the joints. This, also gummed up the works until it was disinterred. In both cases the oil was strained through fine cheesecloth before using it again. M. B. THURSTON.

Boston, Mass.

How Heating of Lead Covering on Cables Was Prevented

Where lead-covered single-conductor cables are used for alternating-current circuits, care must be exercised to arrange the cables of the same circuit together so as to eliminate heating of the lead sheath so far as possible.

A three-phase 440-volt circuit was made up of nine 250,000-circ. mil single-conductor lead-covered cables. To bring the cables to the oil switch they were arranged



Figs. 1 and 2—Two ways in which the cables were grouped

With the grouping shown in Fig. 1 the temperature of the lead sheaths on the cables became dangerously high, which was remedied by using the grouping shown in Fig. 2.

and supported as in Fig. 1. This made a neat job, but the three cables of each phase were placed together. The circuit had not been in service long before it was discovered that the lead sheaths were operating at what was considered a dangerous temperature. This heating was eliminated to a large extent by arranging the cables as in Fig. 2. In this scheme each of the three groups contains an *A*, *B*, and *C* cable and is much more effective in neutralizing the effects of the magnetic field of the different phases. H. W. SAWYER.

Cleveland, Ohio.

Comments from Readers

Are Welded Pressure Tanks Safe?

I have read with interest the comments of Ing. R. Th. Heinrici, which appeared in the May 4 issue. There are, however, one or two points that bear on my article in the Feb. 23 issue, to which I should like to reply and would therefore beg space in your columns.

In the first place, I cannot agree with Mr. Heinrici's statement, "The so-called oxyacetylene welding is not a welding process at all and is in fact soldering," because his term "soldering" does not describe adequately the effect of oxyacetylene welding, which, strictly speaking, is welding by fusion. True, the term "welding" meant originally the union of two pieces of metal within their plastic range but below their melting point, as in an ordinary blacksmith's forge weld. Oxyacetylene welding is a very different craft from blacksmithing; indeed, with the first-named it is possible to accomplish many tasks in power plants which could not possibly be done by the blacksmith. Modern processes (gas, hydrogen-arc and electric welding) have broadened the definition of welding and brought in use additional processes to which the term "welding" is applied.

The term "soldering" in this connection is hardly appropriate, as the metal surfaces to be united are actually fused or melted, thereby causing them to flow together; thus the oxyacetylene-torch process is more akin to welding than to soldering proper. Soldering is the art of uniting all surfaces of metals by partial fusion, and the insertion of an alloy between the edges that is called solder, it being more fusible than the metals it unites.

Moreover, oxyacetylene welding provides better, neater appearing and more lasting joints than hitherto attainable by soldering methods. Welded joints can be built up to give added strength if desired, and the metal left in a satisfactory condition for subsequent machining. Oxyacetylene welding is not confined to production work alone, but can be used to tremendous advantage in power plants in the repair of worn or damaged metal parts, with the same features of simplicity, economy and efficiency.

Experience shows the writer that no system of welding is universally applicable, technical or commercial limitations, or both, being inevitably encountered sooner or later. To illustrate the fact that no system of welding is suitable for all conditions, experiments were recently carried out by a pressure-tank fabricating concern which manufactured a number of cylindrical vessels of various dimensions for high pressures. The maximum effective results were obtained in the tanks where the longitudinal body seams were welded by the water-gas process, the ends and the flanges by the carbon-arc process, and the branches by oxyacetylene. Obviously, each system of modern welding has its own particular spheres of applicability, to which it should be confined if maximum technical efficiency and commercial economy are to be secured. E. ANDREWS.

Manchester, England.

Writing Yourself to the Fore

Considerable discussion has already taken place on "Writing Yourself to the Fore," but the letter in the May 11 issue by James McIntosh brought to mind some of my experiences which I thought might be of interest.

I had my first setback right at the start, some years ago while working as a draftsman. The idea occurred to me that the purchaser and incidentally other engineers would be interested in knowing why certain types of equipment were selected in preference to others as dictated by local conditions at the point of installation. I was given permission to write the article, but upon presenting it to my superiors for inspection before submitting it to the publisher, the liberty of publication was denied, with the assertion that the less a customer knew about the equipment, the easier it was to sell it to him.

However, when I am placed in the position of buyer or making recommendations for a purchase, I want to know all about what I am buying, and I observe that in recent years it is evident that other engineers and purchasers of equipment feel the same. I have always contended that the purchaser of equipment should know more than he usually does, as he is the one that suffers when things go wrong. The activities of the N.E.L.A. should be appreciated by all engineers for the information brought out in recent years by the various committees.

A manufacturer of first-class equipment welcomes the desire to know the "why and how" of his equipment and appreciates the interest shown.

The firms that think they have something under their hats are the hardest to get along with for a man with ambition who wants to do things. I have spent the last ten years with a corporation that welcomes the desire of their engineers to prepare papers for presentation to engineering societies or for trade paper publication. I have in consequence several major articles to my credit.

While in Europe several years ago, I found that European manufacturers apparently were closer in respect to giving out information than manufacturers generally are in this country. I found, however, that in many instances what they thought were secrets were in reality discussed in open meetings or conventions in this country. On the other hand, I noticed that many European periodicals seem to be able to get more information and drawings for publication than periodicals do in this country.

My advice to aspiring technical writers is to find out first how your superior will take it, for there is a lot of jealousy in this world as long as you remain in a subordinate position. When you get to be head or become responsible for things, you can use your own judgment. In all probability you will then find that you do not have much time for excess writing.

Akron, Ohio. A. H. MYERS.

Steam Temperatures at Gennevilliers

Referring to the article on steam temperatures at Gennevilliers in the June 15 issue, Mr. Rauber, superintendent of station, states that turbine No. 6 was opened up again at the end of April, 1926, for its annual overhauling (after nearly four months of additional service, or a total of 6½ months, under the steam conditions outlined in the article, namely, temperatures running up to 915 deg. F.). The only sign of trouble detected was a slight distortion of the first guide vanes. This defect was so slight, however, that it interfered in no way with the operation of the turbine, nor did it impair its efficiency. The unit was put back into service at once.

Following this examination, however, it was thought best to make the necessary alterations in the boilers, to reduce the superheat somewhat; for regular operation of the turbine at these high temperatures would require an increase in the stiffness of the guide vanes, an alteration hardly to be considered at the present time.

In the writer's opinion there is nothing so far in this experience to indicate that turbine materials cannot be made to stand up under steam temperatures materially higher than those sanctioned by present practice.

Paris. R. H. ANDREWS.

Gage for Checking Wear on Crankshaft Bearings

A gage for checking the wear on crankshaft bearings was described by M. C. Cockshott in the March 30 issue. There is no doubt that this type of gage is simple and easy to make, but to my mind it has one serious disadvantage; that is, it is not nearly accurate enough for the purpose for which it was intended. Its accuracy can hardly be better than about 0.015 in.

An illustration of this gage is reproduced in Fig. 1, from which it will be seen that in order to check the heights of the various bearings it will be necessary to scribe or mark a line at the point *X* for each individual bearing on the piece of hexagon bar *A* which passes

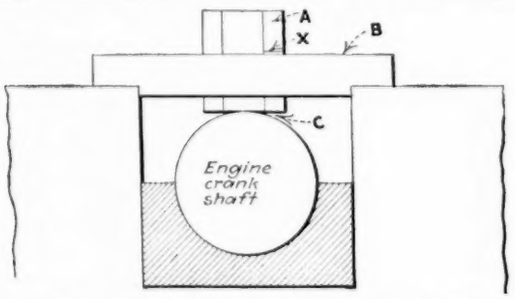


Fig. 1—Improvised gage suggested by Mr. Cockshott

through the bridge *B*. If there are more than six bearings in the engine, it would not be possible to mark the heights of all the bearings on the one piece of bar.

If any wear takes place in the bearings, and as the various lines will probably have disappeared below the surface of the bridge, it will be necessary to insert feelers at the point *C*, between the bar and the shaft, till the scribed lines return to their normal position, the amount of wear being indicated by the thickness of feelers used.

A gage which I have used extensively for this purpose is shown in Fig. 2. This consists of a piece of ½x1-in. mild steel *D* bent as shown, the two bottom faces *E* being machined or filed true with each other. A dial gage *F* to read to 0.001 in. is suspended by a piece of ⅜-in. round bar *G* from the main frame. The gage can be adjusted for height and locked in position by means of the setscrew *H*.

In setting a gage of this type, it is necessary to obtain the dimension *J* in Fig. 2 and to make two

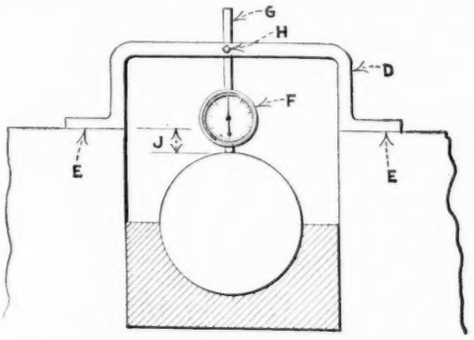


Fig. 2—Method of using dial gage in checking bearings

parallel bars or blocks which will be kept for setting purposes. The gage is set up in the following manner on a surface plate or flat machined surface: The parallel bars are placed below the machined feet *E* and the dial gage adjusted downward till it touches the machined face. It can then be locked in position with the pointer at zero. It is now possible to take a permanent record of the actual bearing heights in the engine by applying to each bearing in turn. In tests of this kind it is necessary to bear in mind that there will be a certain amount of wear on the shaft, although the major portion of the wear will be in the bearing.

Glasgow, Scotland. DOUGLAS P. MUIRHEAD.

Engineers' Wages

I was much interested in the "Foreword" in the March 23 issue on "Power-Plant Engineers' Wages" and the several discussions which have followed.

I am a firm believer in the truth of the old adage that "Those that do no more than they are paid for, never get paid for any more than they do," and that faithful, conscientious effort will bring its reward. I am loath to believe that all employers are not wide awake to the merits of their men, and especially to the chief of the power plant.

An example of what a man can do against the odds of ignorance and lack of interest, is in the case of a new man in an old plant near here. This plant was an ordinary one of about 1,000 hp. and for a number of years had been run by some "chiefs" that looked on it as a meal ticket and spent about 90 per cent of their time telling visitors that if they had so and so, they could do so and so, and what a crime it was that men of their ability had to waste their time in such a plant for such small wages, etc.

Well, about three years ago a new chief took over the plant, and he at once gave the men to understand that the old order of doing things had passed and that a new régime was in force. In a short time the plant began to take on a new appearance. The dirt and grime disappeared. The hissing of steam from numerous

leaks stopped. The dripping of water from leaks in the water line ceased. The engines and turbines were given a coat of paint. The men themselves began to "pep" up and take a pride in the plant. Then the bosses sat up and began to take notice, for the plant looked as if someone lived there and was on the job.

The new chief rigged up some home-made draft gages and gas collectors. He borrowed an Orsat and showed the boss the results of hand regulation of dampers and drafts. He made a statement of the cost of the things that he needed, what they would reasonably save, and the boss got them for him.

It wasn't long before the boss began to bring visitors in and to boast a little about our plant. In three years this man reduced the labor of the plant from 16 men to 12, reduced the coal consumption from 75 to 52.6 tons per day (anthracite culm), made a reduction in oils and other materials and awakened a spirit among the men that is bringing better results. During all this time no man heard him say a word about his wages or about the company not getting him anything. He simply went ahead with what he had and showed them what he would do if he had other and better things. His wages at the start were $200 a month; now he is getting $250 and the end is not in sight.

This shows, in my opinion, that the man that will take the things that he has to hand and show that he means business, and not hand out the alibi "if I had this I would or could do that" to the boss, if he will show the boss that he does not mean to waste his money on non-producing things, then nine times out of ten the boss will meet him half way, and he will certainly earn more than a brick-mason or a mail-carrier.

Wilkesbarre, Pa. THOMAS M. STREET.

Big Business—How To Keep It Beneficent

With reference to the editorial in the April 13 issue entitled "Big Business—How to Keep It Beneficent," the following comes to mind: What evidence is there to support the belief that big business is likely or inclined to be beneficent? A recent experience in Toledo was that three days after a large bakery merger took effect, the price of bread advanced 2c. a loaf, and this in face of the fact that flour declined some 40c. a barrel, sugar declined, and milk and wages remained the same.

The idea that trusts represent a concentration of means and effort toward economical service to the public is open to serious question. There is a widespread belief that huge combinations can do things with greater efficiency than smaller concerns. If that were true, how could a small concern exist at all, whereas the fact is that many do exist and are doing well? I think that conclusion can be arrived at only by disregarding several important facts.

In general, a concern has to be of a certain size before economical production can be obtained, but that size is much less than that of a trust. For example, a bakery that reaches a size that requires the output of one continuous oven has little to gain in economical production and distribution by merely increasing the size.

It has been frequently said that the smaller automobile concerns would either be gobbled up or wiped out by a few large companies, but still several small companies continue to prosper. Those of us who have done industrial engineering for them can readily see why that is. There are many small concerns making automobile parts that are doing well indeed. An important point here is that those small concerns seem to originate many of the improvements of automobiles. It is quite a puzzle to many of these large concerns that they can often buy many parts, say forgings, cheaper than they can make them. The best ideas seem to come from those smaller concerns. It is simply a case where men who have opportunities for large rewards are competing with other men who are in the employ of the larger concerns at more or less fixed salaries.

It is generally accepted that public utilities as monopolies render better service than competing concerns. That appears to be true only for a limited time, for it seems that the charge for such service tends to rise to a competitive level, or to the level where people begin to do without it or use various substitutes—in other words, to the maximum the traffic will bear. A recent instance is that of a gas concern in a city of about 100,000 population which obtained rate increases until it got the cost of gas to the point where the people began to use oil stoves and individual gas plants.

Take the traction situation in a great many cities. I submit that this condition was brought about as a consequence of the granting of monopolistic franchises which engendered management policies based on the idea that no competition was possible, with the result that no research work toward giving better service at a lower cost was done. The blunders that characterized the management of these properties were the natural outcome of parsimonious salaries of those overworked individuals who were directly responsible.

As a further consequence of the underpaid engineering and management, the traction companies refused to recognize the automobile as a competitor until nearly too late for most of them. Now they want the automobile restricted by fiat laws, and one may see expensive lobbying in favor of gasoline taxes.

My main point is that the idea of monopoly is in opposition to the process of creation and improvement.

The creation of variants, then the selection of the best of those variants for the generation of more variants, the selection of the best of those, and so on indefinitely. Monopolies kill variations and improvements. The reason they do not altogether kill progress is because they cannot be made absolute—variation and competition will exist in some form.

Is this not the basic reason why large utility companies will buy several types of turbine units? Can there be one best steam turbine except for a short time? Could we get better units through a monopoly?

There is good ground for faith that those manufacturers who blindly shut down their own plants and buy central-station power when a large part of that power could be generated in their own plant much cheaper will, in the absence of monopoly, give way to those manufacturers who have done differently. With the continual increases in rates granted by the various rate-making bodies, the isolated plant will stage a comeback. The one main thing that works against it now is that the central stations make special efforts to take care of that situation. It is a well-known fact that the real basis of rates to a large consumer is the cost at which that consumer can make his own power. The small consumer is the goat, and will continue to be until someone invents small power plants that will give him light and power at a lower cost than does the central station.

Toledo, Ohio. J. R. BELKNAP.

New and Improved Equipment

McClave Chain-Grate Stoker for Anthracite and Coke Breeze

The McClave-Brooks Co., Scranton, Pa., has recently extended its line of combustion equipment by the addition of two types of chain-grate stokers, one of which is designed especially for anthracite and coke breeze and is illustrated herewith, and the other for bituminous and lignite fuels. The latter will be illustrated in a later issue.

The anthracite stoker is a combined forced- and natural-draft unit permitting natural-draft operation within the limits of the draft available and the use of forced draft for overload peaks and continuous over-ratings. Fig. 1 is a general view of the stoker, and Fig. 2 shows the arrangement of the air compartments.

The wind-box is placed along one side of the stoker, and the forced-draft dampers *A* and natural draft damper *B*, Fig. 2, are controlled from the side of the wind-box by the levers, as indicated at *C*, Fig. 1. A feature of these controls is the method of securing the levers in any desired position. This is accomplished by simply giving the handle about one-eighth of a turn.

For removing the siftings from the bottom of the air compartments at intervals, a replaceable link chain as shown in Fig. 3 is provided. The sprockets at the wind-box end of the chain are keyed to a common shaft which is driven by a small motor through a reduction gear *D* at the front of the stoker. The siftings are carried by the chain into an ash ejector in the bottom of the wind-box, which discharges them to the ashpit.

For driving the stoker two types of drives are available. The ratchet drive shown in Fig. 1 is recommended for stokers of 60 sq.ft. of grate area or less where a more expensive type of drive would not be warranted. For the larger stoker a spur-gear drive, giving three different speeds, has been developed. The different speeds are regulated by two hand levers on the front side of the gear housing. The lever shifts a spiral clutch on the main driving shaft in contact with clutches on the gears. A special locking device allows only one speed change at a time. A safety attachment is provided on the main driving shaft as a protective measure for any part of the stoker while in operation. With the ratchet drive shown in Fig. 1, four speeds can be obtained by increasing or decreasing the throw of the ratchet lever arm. A spring safety feature is incorporated in the drive to absorb the strain and prevent the driving shaft from functioning should the stoker mechanism become caught in any way. The

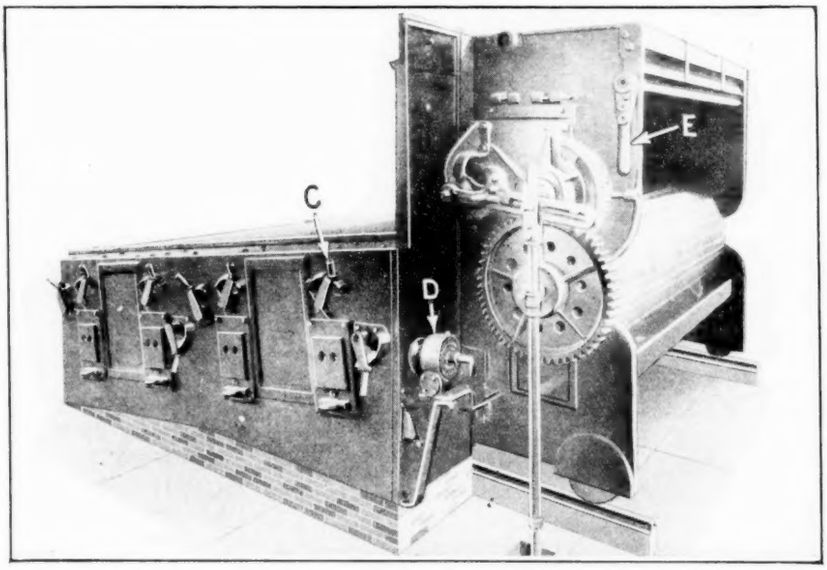


Fig. 1—Anthracite stoker arranged for forced and natural draft operation

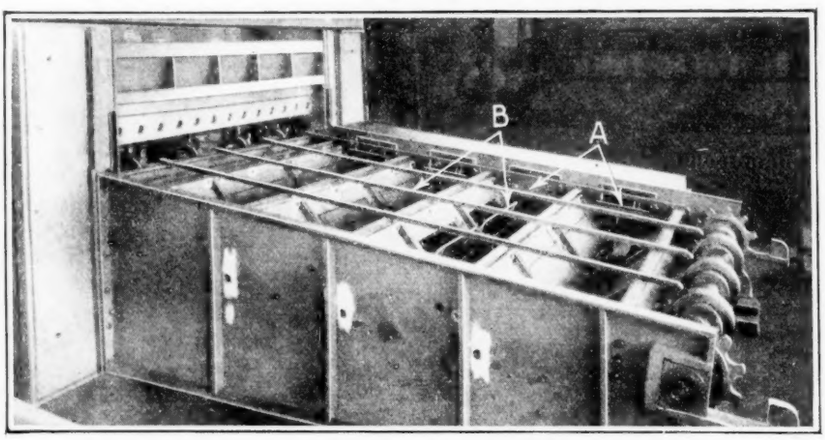


Fig. 2—Arrangement of air compartments and dampers

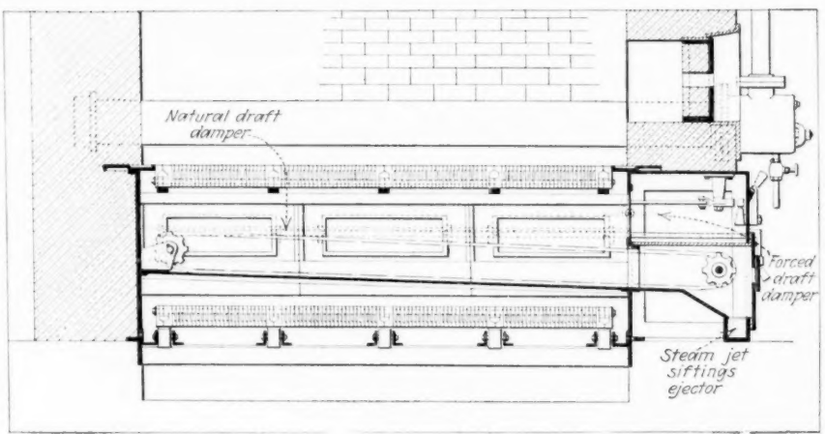


Fig. 3—Sectional view showing sifting remover

driving lever is operated by an eccentric from a shaft overhead or below the floor, as best suits installation requirements.

The hopper apron is raised and lowered by means of a hand ratchet on the end of the stoker hopper, as at *E*, Fig. 1. This affords quick access to the

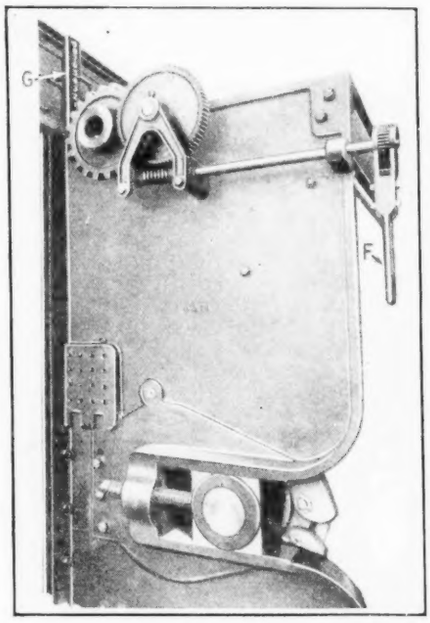


Fig. 4—Fuel gate operating and grate adjustment mechanism

fuel gate for the replacement of the tile brick or other repairs.

The height of the coal gate, which slides vertically in guides bolted to the hopper sides, is regulated by means of the ratchet *F* and suitable gearing, as shown in Fig. 4, the indicator *G* being provided to show the number of inches the gate is open. The fire side of the fuel gate is lined with tile brick which

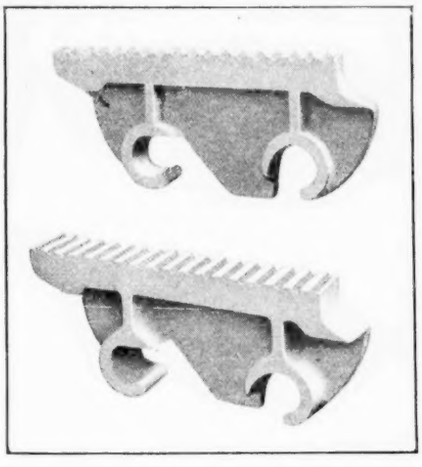


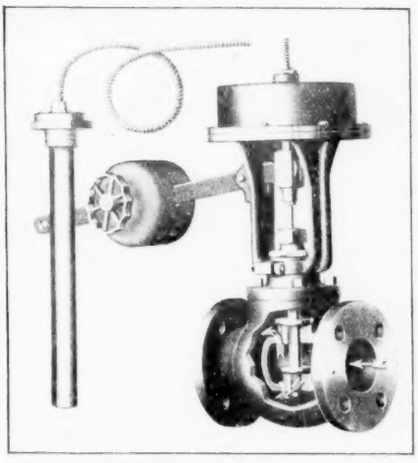
Fig. 5—Regular and sprocket links used on anthracite stoker

are held in place by cast-iron brackets, each brick being separately supported.

Other features of the stoker are the employment of round bars in place of oval or special shapes and making the chain entirely of removable links, Fig. 5. This obviates the necessity of carrying special repair links in stock, as each link is standard or uniform and any link can be replaced while the stoker is in operation, a specially designed jack being provided to facilitate this work. High- and low-pressure water backs for locating at the rear end of the stokers are also available.

New Klipfel Vapor Thermostat

A new vapor thermostat designated as Klipfel No. 48 has been announced by the Klipfel Manufacturing Co., of Chicago. Its principal use is the control of hot-water tanks at any desired temperature between 140 and 180 deg. F., although it can be made for other temperature ranges required for the thermostatic regulation of dry kilns, gas-fired ovens, enameling ovens, cook-



New Klipfel No. 48 vapor thermostat

ers, evaporators, vulcanizers, pasteurizing machines and other applications requiring close temperature control.

The only moving parts of this new device are a semi-balanced bevel-seated bronze inner valve and a metal bellows. Both are easily accessible should it be necessary to remove or replace them. Normally, the inner valve is held open by weighting on the lever arm. As the tank water or gases rise above the predetermined temperature for which the weighting has been adjusted, the volatile fluid (hermetically sealed within the temperature sensitive bulb shown at the left in the illustration) boils, increasing the pressure in the all-metal bellows. The increase of pressure lifts the weighting and so closes the steam supply valve.

This valve is available in sizes of ½, ¾, 1, 1¼, 1½ in. and continuing in steps of ½ in. up to 6 in. The bulbs are 16 in. long, with taper threaded bushings 1-in. pipe size on all sizes up to 2½-in. For sizes of 3-in. and above, the bulbs are 24 in. long and have taper threaded bushings of 1¼-in. pipe size. The valves are made globe pattern only.

Cochrane Improved Pressure Filter

An improved mechanical pressure filter on which the usual strainer heads and collecting manifolds have been eliminated and other changes have been made to give more uniform distribution of the flow through the sand layer when filtering and better distribution of the flow in back-washing, has been brought out by the Cochrane Corp., Philadelphia, Pa.

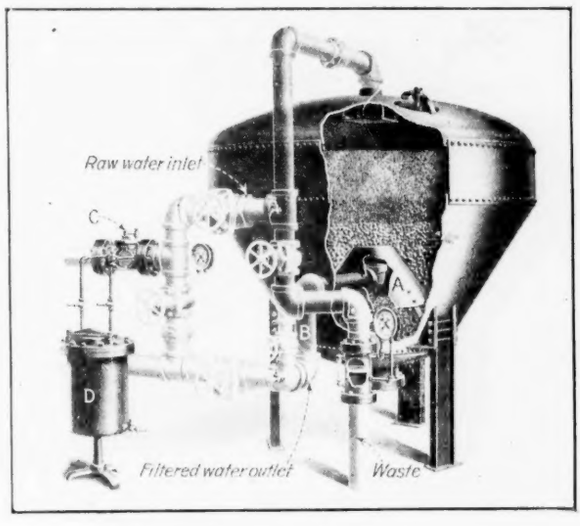
The body of the filter is partly cylindrical and partly conical, as shown in the illustration, the cylindrical portion being occupied by the fine filtering sand. Underneath the layer of sand are two layers of gravel and beneath that a layer of pebbles. Embedded in the pebbles is an inverted cone *A* from the apex of which the water is withdrawn. The water enters the filter at the top and passes downward through the filtering material, finally leaving through the pipe *B*.

By virtue of the design the velocity of the water through the fine sand is much lower than through the coarser material. This feature tends to obviate the carrying over of fine particles of sand even at high rates of back washing.

The filter is regularly supplied with an orifice and differential pressure gage for measuring the rates of back-washing. Where the back-wash connection is to a closed pipe, a sight glass is also connected around the orifice plate to enable the operator to determine when the back-wash is complete.

To facilitate the removal of the filtering material, should that become necessary, a door is provided on the bottom of the filter through which the complete filtering material can be removed. Fresh filtering material is charged in proper order through the top manhole.

The illustration shows the general piping arrangement with bypass connections, also an adjustable orifice valve *C* and coagulant tank *D* connected in the water line to the filter.



View of filter and connections

Eight Hundred Pound Steam Carried by Belgian Plant

UNDER the enterprising management of M. Leopold Herry, its chief engineer, the Centrales Electriques des Flandres at Langerbrugge, near Ghent, Belgium, has put itself in the forefront of central-station practice by using steam at the highest temperature yet commercially adopted in the world and at the highest pressures for which ordinary boilermaking methods are adequate. According to *The Engineer*, the Langerbrugge station now contains three boilers, capable of a normal aggregate output of 79,200 lb. of steam per hour, working at a gage pressure of 800 lb. per sq.in. and at a temperature of 842 deg. F. The size of the installation takes it out of the class of experiments, in the usual sense of the word, and testifies to an engineering courage on the part of the engineer and the builders of the machinery, which appears to have been abundantly justified by results.

Fifteen Hundred Pounds Considered

It was the first intention to adopt a pressure very considerably in excess of that eventually selected. Pressures up to as high as 1,500 lb. per sq.in. were seriously discussed, and it was not any doubt of the practicability or the safety of such pressures which led to the final adoption of 800 lb. The reason lay in the conditions of the station. The existing plant was working with steam at a pressure of 285 lb. and a temperature of 625 deg. F. It was very advisable that the new plant should exhaust into that range, thus contributing to the steam supply of the existing turbines, rather than using an independent turbine for the final expansion of the high-pressure steam. It followed, therefore, that the steam, after leaving the high-pressure turbine, should still carry a considerable amount of superheat, so as to approximate to the range conditions. The best way to secure that object was to work with the highest possible temperature in the first place and to choose such a pressure that a sufficient superheat would still remain after the steam had been reduced by the first turbine to a pressure of 285 lb.

These considerations indicated an initial pressure of 810 lb. and an initial temperature of 826 deg. F., the latter being the highest steam temperature ever commercially used. Had a much higher initial pressure been chosen, the steam after expansion to the range pressure would have been insufficiently superheated or even wet, and it was the wish to avoid the complications of reheating. What was done, in short, was to compound the station, by adding a high-pressure plant suitable to work in conjunction with the existing plant.

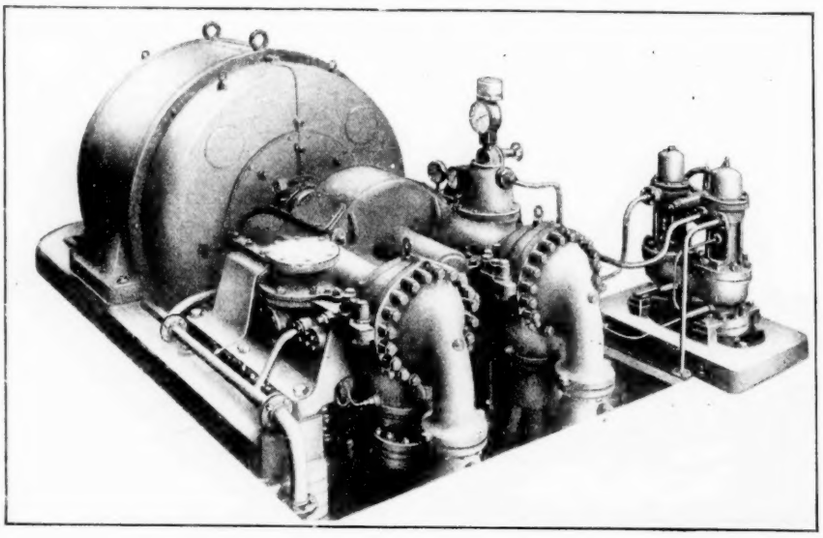
The high-pressure equipment consists of three boilers and a turbo-generator, together with all the necessary auxiliary apparatus. The boilers are of the Babcock & Wilcox marine-type with chain-grate stokers and air heaters. No economizers are provided, as the feed water is heated to 384 deg. F. by steam before entering the boilers.

The boiler drums, which are 3 ft. 6 in. internal diameter, are not of the hollow forged construction that has been adopted for high pressures in certain cases, but are built up of plates in the usual way. The shell is 1¾ in. thick and is strengthened with a plate of equal thickness where it is entered by the tubes. All the water tubes are 3 in. in diameter and 13 ft. long. The superheater tubes are 1½ in. in diameter and are expanded into cylindrical headers. The water level in the drum is shown by a Burnett-Brearley indicator, which consists of a pointer actuated by the weight of a movable chamber.

Immediately behind the boiler, and the full width of the latter, is an air heater of tubular type. The flue gases enter this at the top, pass down through a nest of straight tubes, 2¼ in. in diameter by 16 ft. long, and are then delivered to the steel stack by the induced-draft fan. The air for the furnaces is circulated around the outside of the tubes by means of baffles and delivered under pressure by the forced-draft fan to the stoker, which is of the compartment type that permits the air supply to any section of the grate to be independently regulated. Although only 7 ft. wide, a flat suspended type of arch has been adopted, as it gives uniform combustion conditions right across the grate.

The turbo-generator to work with the new plant at Langerbrugge was designed and built by Brown, Boveri & Co., Ltd., of Baden. The turbine is constructed to take steam at the stop valve at a gage pressure of 710 lb. per sq.in. and at a temperature of 828 deg. F. It exhausts at a gage pressure of about 285 lb. into the main steam range of the station. The rated output of the plant under these conditions is 2,000 kva.

There are two separate two-stage impulse turbines, working in series with each other, as regards the steam flow, and in parallel with each other mechanically. Each turbine consists of two single impulse wheels, having a mean blade diameter of 14¾ in., and running at 8,000 r.p.m. The turbines are overhung on their shafts, thus avoiding the difficulty of high-pressure packing, and they drive the alternator at a speed of 1,500 r.p.m., by means of reduction gearing. Cast steel is used for the turbine casings, the wheels, blading and labyrinth packings being of special alloy steel.



Twin high-pressure turbine

Steam from the boilers is admitted by the stop valve which stands apart from the turbine proper, as shown in the illustration. Alongside the stop valve and working in the same casing is the governor valve, which is operated by an oil pressure relay under the control of the centrifugal governor. The only connections between the valve gear and the turbine are flexible pipes. Instead of single steam pipes being used, the connections are made by a number of "macaroni pipes," as they are called in the station, working in parallel with each other and enclosed in a pipe casing. The idea is to secure perfect flexibility, so that no expansion of the steam pipe, or distortion due to temperature or pressure, can possibly affect the turbines or their gearing.

Recent Publications

The Theory of Measurement. By Lucius Tuttle and John Satterly. Longmans, Green & Co., London and New York, 1925. Cloth; 5½ x 8½ in.; 333 pages; illustrated. Price, $4.50.

This excellent work is devoted to the consideration of accuracy as applied to scientific measurements and calculations. Much elementary information is included in the opening chapters, so the the book should be intelligible and helpful even to those having limited mathematical training. While the book is characterized by showing in some places methods of attack and points of view not ordinarily met in this country, but common in England, it has the great advantage that the material is taken up in a practical commen-sense spirit, rather than as an opportunity for the display of mathematical fireworks. The subject of the occurrence and distribution of errors is discussed and illustrated in a clear and practical way, and only 20 pages are given to the theory of least squares, which is developed without the presentation of the mathematical demonstrations with which books on this subject are usually filled, to the confusion of most readers who desire help in the conduct of their every-day work.

The book is plainly designed for classroom use, but there is no reason why it should not prove equally helpful to the individual student, for the explanations given are very full, and assume no knowledge of mathematics beyond arithmetic and elementary algebra.

The first few chapters on abridged arithmetic, methods of measurement, significant figures, logarithms and the slide rule, graphical representation and analysis, and similar elementary matters, should prove very helpful to those who are entering upon work involving experimental observation and calculation. The later chapters discuss the theory and distribution of errors in a delightfully simple manner, entirely unobscured by the mathematical analysis so commonly associated with this subject, and the illustrations are drawn from the field of mechanics and statistics in terms understandable to any intelligent person, and not, as is frequently the case in treatises on this subject, from the field of astronomy and surveying in terms understood only by specialists in those fields.

The book is to be recommended to those who are interested in this subject from a practical point of view. The reader who seeks mathematical theory will probably find the book rather unsatisfying.

Surface Water Supply of Canada-Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada in Alberta, Saskatchewan, Manitoba and Western Ontario. Climatic Year 1922-23, Water Resource Paper No. 44, Department of the Interior, Canada, Dominion Water Power Branch. Published by F. A. Acland, Ottawa, Canada.

The Design of Gravity Circulation Water Heating Systems. By F. E. Giesecke, Ph. D., Professor of Architectural Engineering and Director of the Engineering Experimental Station, University of Texas. Published by Heating & Ventilating Magazine Co., 1123 Broadway, New York City. Cloth; 6x9 in.; 74 pages; numerous diagrams and tables. Price, $3.

This treatise is a revised and enlarged edition of a series of articles published in the *Heating and Ventilating Magazine*. Its object is to explain and present a method of designing water-heating systems which is scientifically accurate and so simple that any intelligent engineer, who has carefully studied the designs of the several systems outlined in this book, will be able to make satisfactory designs of any similar systems he may encounter in his practice. The six chapters cover the following subjects: Fundamental explanations, the elementary heating system, the one-pipe heating system, the two-pipe heating system, direct and reversed return, systems with overhead distribution. The directness and brevity of the book are among the features recommending it to those wishing to acquire the essentials with a minimum waste effort. Tables and diagrams in the back give the dimensions of standard piping, pressures due to various heads of water at various temperatures, friction heads, etc.

The Bulletin of the School of Mines & Metallurgy of the University of Missouri, for February, 1926, is devoted to Electrical Precipitation as Applied to Gas Streams. This compilation, prepared by H. R. Hanley, associate professor of metallurgy in the Missouri School of Mines and Metallurgy, is a comprehensive collection of quotations from numerous sources covering almost all aspects of electrical precipitation. The material is collected under a variety of special headings, without any particular logical connection, but the pamphlet, comprising 64 pages, with a number of illustrations, should prove very valuable to power-plant engineers that are interested in the subject of the removal of dust from gas streams. Professor Hanley has contributed a valuable service to the industry in preparing this painstaking compilation.

Regulators for Generator Voltage Control is the title given to bulletin S. P. 1734, recently published by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. This bulletin is not a catalog, but in reality a 55-page textbook, describing the operation of the various types of generator automatic-voltage regulators built by that company. The problems in voltage regulation are also discussed. Headings under which the main subjects are considered are: Regulators for direct-current generators; vibrating-type regulators for alternating-current generators; the application of direct-current generator regulators to exciter service; compensation for voltage drop and parallel operation of regulators; rheostatic-type automatic-voltage regulators; extended broad-range regulators; special regulator operations, such as speed regulators, power-factor regulators. This book has been written by the company's engineers and, among other data, contains information that has not previously been made available. For all who are interested in voltage regulators, this book will be found to be of valuable assistance.

How to Make High-Pressure Transformers for Radio and Power Apparatus. By Prof. F. E. Austin, published by the Webster Press, Hanover, N. H. Cloth; 5x7½ in.; 77 pages; 22 illustrations. Price, $1.25.

This little book shows how to go about designing small transformers. The design for three different sizes of small transformers are worked out in detail. How the construction work is done, is clearly shown by illustrations. To those who are interested in building small transformers for experimental work, this book should be of assistance.

Yallourn and the Associated Electricity Schemes of Victoria, is the title of a 79-page booklet, by S. Edgar Barratt, published recently by the Australasian *Electrical Times*, Melbourne, Victoria, Australia, the price of which is 5 shillings. This publication gives a résumé of the activities of the State Electricity Commission of Victoria from 1919 to 1925; the mining of brown coal; Yallourn power station; design and construction of a 132,000-volt transmission line 104 miles long; the Yallaville switching station; the Newport power station; distribution in metropolitan and country districts; briquetting; and hydro-electric power generation. The Yallourn plant has been laid out for an ultimate capacity of 150,000 kw. and has 62,500 kw. installed. The fuel burned is brown coal containing 48 per cent moisture. Drawings and other data are presented which give a good description of this installation and its engineering features.

Effect of Surface Materials on Steel Welding Rods—Chicago Steel & Wire Company, 103rd St. and Torrence Ave. This is only incidentally a catalog of rods for gas and electric welding. Two-thirds of the space is devoted to a scientific discussion of the principles underlying successful welding so far as the composition, physical conditions and surface of the welding wire are concerned. Particular attention is given to the effect of various factors on arc stability. The booklet is prepared by the company's research department on fusion welding.

Can We Compete Abroad? By C. C. Martin. Published by the National Trade Council, India House, New York City, "as a contribution to the literature of American foreign trade." Paper; 155 pages. Price, 25 cents. A brief account of modern American achievement in foreign commerce, giving records of American trade advance abroad since the old clipper days. In a clear and very readable style the author presents testimony from fact carefully investigated and correlated.

News in the Field of Power

Alabama Power Co. Resumes Use of Wilson Dam

An agreement under which the Alabama Power Co. will immediately renew its purchase of hydro-electric power generated at the Wilson Dam, Muscle Shoals, Ala., was signed July 15, at Washington, D. C., by representatives of the company and army engineers.

Under the new arrangement which was effective immediately and extends until Dec. 6 when Congress will reconvene, the power company will pay a slightly increased rate for the Wilson Dam power.

The agreement is described as mutually advantageous to the purchaser and government interests.

Tyler Plan Impracticable

It was worked out in conferences which have been progressing between the engineers and power company representatives since the company recently refused to continue taking power generated by the dam units under the scheme recommended by Major Tyler, engineer officer in charge of Muscle Shoals. Major Tyler's plan was declared impracticable by the power company operators, not only because it imposed increased rates, but compelled the power company management to operate the steam power plant in conjunction with the hydro-electric plant regardless of certain economic factors.

These difficulties were ironed out by the conferees and the working arrangement set up is said to be satisfactory to all concerned.

Steady Output Assured

The power company officials are to be well satisfied with the new contract. They pointed out that the previous arrangement ran on a day to day basis only and was subject to cancellation at any time, whereas, the new agreement assures them of a continuous product from the dam until congress reconvenes and again takes up the questions of disposing of the Muscle Shoals properties.

Consummation of this agreement allowed the immediate resumption of the export of 20,000 kw. to the Carolinas. This delivery of power had been cut off since July 3. It also puts the Alabama Power Co. in a position to greatly increase its exports of power both to the Northeast and to its interconnected system in Mississippi. While the line capacity from Muscle Shoals is limited to 85,000 kw., an additional 80,000 kw. can be developed at the Gorgas and Gadsden steam plants in case there should be a demand for more power.

Under the present arrangement little use is likely to be made of the Sheffield steam plant. It would be used only in the case of very low water or generator trouble. The generators at the dam are still under test. Rewinding has been necessary on certain of the units.

New York Power Groups May Merge Plants

A petition for acquisition of the Syracuse Lighting Co., the Seneca River Power Co., of Baldwinsville, and the Mexico Electric Co. of Mexico, was represented to the Public Service Commission July 16 by the Mohawk-Hudson Power Co. of Albany, N. Y.

The companies for which permission to purchase was requested have an estimated total valuation of nearly $30,000,000.

Charles S. Ruffner, of Albany, president of the Mohawk-Hudson Co., said that if the Public Service Commission grants permission, stock of the Mohawk-Hudson Co. will be exchanged for the specified stock of the other companies in order to acquire partial or complete control.

Adjournment Asked

While no objections were voiced against the Mohawk-Hudson Co. plan, Fred D. Corey, president of the Niagara, Lockport & Ontario Power Co., of Buffalo, asked the commission to adjourn the case two weeks, in order to give his company time to study the petition.

Mr. Corey would not say his company was opposed to the petition, but explained that the Niagara concern operates in the Syracuse territory. The commission, however, received testimony from President Ruffner, of the Mohawk-Hudson concern, on his petition.

The proposition, it is reported, requires granting of a petition for the formation of a financing corporation by the Mohawk-Hudson, to be known as the Syracuse Securities Corp. and taking over the common stock of the Syracuse Lighting Co. valued at $4,834,600.

In the case of the Seneca River Power and the Mexico Electric concerns, the transaction is proposed to be an outright one between the Mohawk-Hudson Co. and the owners of the smaller power enterprises, which, it was said, are owned by the United Gas Co., of Philadelphia.

Army Engineers Survey Cost of Tennessee River Power

Estimates totaling $159,000,000 are given for development of potential water power resources in a portion of the Tennessee River basin, a partial report on which is about to be published and distributed as a government document. The examinations on which the data are based and which the report covers are being made by Department of War engineers. The document constitutes a progress report on a comprehensive survey of the Tennessee River and its tributaries in the interest of a maximum development of the water resources of that basin. Bearing also on interstate navigation, it pictures the power possibilities of sites in one of the largest of the country's drainage areas.

The magnitude and value of the various power possibilities in this basin, the report says, vary between wide limits. "At Muscle Shoals," it explains, "is a feasible project justifying a total installation of at least 840,000 hp., while at the other extreme could be found many brooks and rivulets where perhaps one or two horsepower only could be economically installed."

The report gives a preliminary estimate of the undeveloped hydro-electric power possibilities of that part of the Tennessee basin covered by the survey of the War Department engineers up to April 15, 1926. The estimate is based on data assembled by the survey and also on estimates made by private power companies. No estimate is yet made by the army engineers of the French Broad and Holston and their tributaries, or of other smaller streams.

Electrical Workers Study Power Problems

The International Brotherhood of Electrical Workers opened a two-weeks' institute on giant power July 19 at the Brookwood Labor College, Katonah, N. Y. The object of the institute will be to study problems of superpower, such as water-power resources, coal, public ownership vs. monopoly ownership, technical developments in electrical power and the significance of superpower to organized labor.

Dr. Arthur W. Calhoun, instructor in economics at the Labor College, will be in charge of general discussions. Outside speakers will include: Senator George W. Norris of Nebraska, Walter N. Polakov, consulting engineer; C. M. Ripley, publicity representative of the General Electric Co.; Captain J. K. Robinson, U. S. N., in charge of construction work at the Brooklyn Navy Yard; Morris L. Cooke, Chairman of the Pennsylvania Power Commission, and James A. Hamilton, Industrial Commissioner of the New York State Department of Labor.

Pacific Power & Light Co. Suffers Fire Loss

The storage warehouse of the Pacific Power & Light Co. at Kennewick, Wash., was recently destroyed by fire, with a loss estimated at over $100,000. Supplies for the entire system from Lewistown, Idaho, to Astoria, Ore., were burned. It is thought that the fire started from sparks from a switch engine.

No serious injury has as yet been reported.

Dr. Millikan Receives Medal at A.S.M.E. Banquet

One of the important features of the A.S.M.E. spring meeting at San Francisco took place at the banquet Wednesday evening, June 30, when Dr. Robert A. Millikan, executive head of the California Institute of Technology, was presented with the A.S.M.E. Medal.

This award was made to Doctor Millikan by the society on account of his unusual contributions to science and to engineering. He has been well known as a physicist for more than thirty years and since his graduation from Oberlin in 1891 has pursued his researches vigorously and with most fruitful results. At the same time he has been author or joint author of at least nine books which are familiar to every student of physics.

Discoveries of Practical Value

While following such apparently abstract researches as the isolating and measurement of the electron and the extension of the ultra-violet spectrum, Doctor Millikan's discoveries have at the same time been of tremendous practical value. His researches upon the electron theory have been of great benefit in the perfecting of both wire and radio communication. His study of the photo-electric effect has brought about commercial transmission of pictures by wire. His experiment in the realm of high vacuum together with those upon the electron theory have resulted in the modern power rectifiers used in wireless and apparently destined to play a large part in power transmission.

These are but a few of the reasons why Secretary Hoover, in his address before the A.S.M.E. last December compared Millikan of today with Faraday of yesterday as the outstanding example of the pure scientist who is of untold benefit to practical engineering.

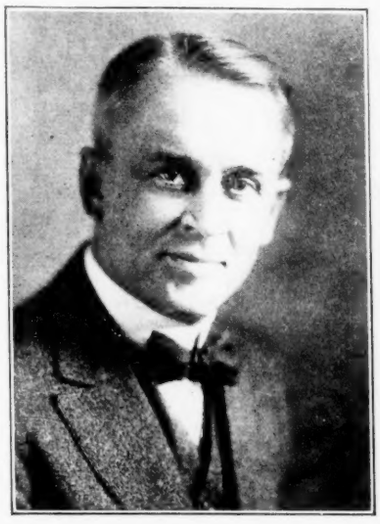
Speaks on Dynamic Laws

William F. Durand, past president, made the presentation address, in which he outlined the scientist's achievements. Following introductory remarks by Warren H. McBryde, chairman of the San Francisco section, Dr. Millikan addressed the meeting on atomic mechanics. In the first part of his address the medalist visualized the modern Samson, seeking to destroy the temple of modern civilization. This destructive Samson would find the supporting pillar in the field of modern science, which, if swept from beneath, would remove the sustaining element of modern life.

M. E. Engineer's Heritage

In science, however, he said, the representative group of ideas underlying present civilization are not to be found in medicine, electricity or chemistry, but in the dynamic laws of Newton and Galileo. Newton formulated the laws based on the experiments of Galileo, which make possible this new era of machinery. The application of these laws made first to terrestrial mechanics about a century and a half ago only within the last century has been made to machine design and construction, and in them we have the heritage of the mechanical engineer.

Dr. Millikan then traced the tremendous advances in the technique of engineering and science during the past twenty-five years. He stated that the laws of conservation of chemical elements, conservation of mass and of energy, and the laws of motion and of electrodynamics, which were recorded as fixed and immutable in 1900, could not now be applied to their entirety. The tendency to generalize too far from the facts on which these laws were based had made them, he said, useless as guides to scientific technique. He



Dr. Robert A. Millikan

explained how in his work of isolating and measuring the electron, for which he was awarded the Nobel prize, even the laws of Newton were not applicable; but that the facts and observations on which these laws were based are as true today as they were when Newton stated them.

Dr. Millikan's address, delivered with the intensity of the enthusiast in science, held his hearers spellbound for nearly an hour.

Rochester Generating Unit Increase Under Way

Word was received recently by the Rochester Gas & Electric Corp., Rochester, N. Y., that materials for the rebuilding of a 25-cycle 10,000 hp. turbo-generating unit at Station No. 3, at Brown's race, have been shipped by the General Electric Co.

When the generating unit is remodeled it will have a production capacity of 15,000 hp. and will work more economically than it did under the old model. It is expected that the work will be finished in September in time for the increased fall demand for power. When this machine is completed, nearly 100,000 hp. can be generated at Station No. 3.

Plans are being made for improvements to the powdered fuel burners and the automatic stokers in the boiler room at the same station. Additional power is being made to take care of any failure of the Genesee River to provide sufficient power for electric generation, which would happen in case of dry weather or accident to hydro-generation system.

Many Nations to Contribute at World Power Congress

Final plans for the World Power Conference to be held this summer at Basle, Switzerland, of which an announcement has previously been published, are now complete. The sessions will continue from Aug. 31 to Sept. 8 instead of to September 12, as at first was stated.

Up to the present 31 countries have signified their intention of participating. These are: Belgium, Brazil, Canada, Colombia, Denmark, Germany, France, Greece, the Gold Coast, Great Britain, Holland, the Dutch East Indies, Italy, Japan, Jugoslavia, Lettland, Lithuania, Luxumburg, Mexico, New Zealand, Norway, Austria, Palestine, Poland, Rumania, Sweden, Switzerland, Spain, Czechoslovakia, Hungary and the United States. In all, 65 reports have been received. Too much space would be needed to enter into details. A complete listing of the American papers, however, was published in *Power*, in the issue of June 29. At the close of the conference a complete report will be printed.

Order of Proceedings

Tuesday, Aug. 31, and Wednesday, Sept. 1, will be given over to the reports on utilization of hydraulic power and inland navigation. Sept. 2 and 3 will be taken up with discussions on railway electrification and electricity in agriculture. On the two following days a special train provided by the Swiss government will take the members to the Gotthard to inspect the electrification work. Papers and reports on hydro-electric and thermal power and power exchange between countries will occupy Sept. 6 and 7. The closing meeting will be held the following day.

Printed copies of the various papers and reports in English, French, Italian and German will be available at the meetings. The papers furnished by the different nations, as well as an abstrac' of the discussions, will be published under the title, "Berichtersttung uber die Baseler Sondertagung der Weltkraftkonferenz 1926."

Participation in the conference is conditioned upon the holding of a card priced at 70 Swiss francs, approval by the president of the Swiss National Committee, and compliance with the rules governing the sessions.

American Delegates

The American delegates who will attend are as follows: O. C. Merrill, general chairman, American Committee; Oliver F. Allen, International General Electric Co., Paris; Dr. Harry E. Clifford, Gordon McKay Professor of Electrical Engineering, Harvard University; Hugh L. Cooper, consulting engineer, New York City; Dr. A. E. Kennelly, professor of electrical engineering, Harvard University; John W. Lieb, vice-president, New York Edison Co., member of the Executive Committee, American Committee; Louis Marburg, Marburg Brothers, Inc., New York City; George A. Orrok, consulting engineer, New York City; David B. Rushmore, member of the Executive Committee, American Committee, and O. G. Thurlow, chief engineer, Alabama Power Co.

New Pumping Station for St. Louis

On the Missouri River at Howard Bend, about eight miles above St. Charles, Mo., is the location of the new pumping station for St. Louis. Construction on the river control work, reservoir and filter plant has been in progress for some time, and development is now reaching the point where the station equipment is being considered.

As an initial installation there are to be four Heine water-tube, cross-drum boilers, furnished with Sewall baffling, each to contain 6,500 sq.ft. of steam-making surface. The boilers are being designed for 400 lb. pressure, but will be operated at 325 lb. gage. They will be equipped with Foster radiant and convection superheaters, designed to give 225 deg. F. of superheat at normal boiler rating and for the first time in a water pumping station, there will be air preheaters that will raise the temperature of the combustion air to 380 deg. F. The preheaters will be of the Ljungstrom type. Provision has been made for two of these units and probably the other two will go in before the plant is in operation.

Stokers will be of the forced-draft, chain-grate type, capable of burning a maximum of 50 lb. of coal per hour per square foot of grate, the fuel being Illinois screenings, having 10,300 B.t.u. per lb. and 16 per cent ash.

In the pumproom, turbine-driven centrifugal units are to be used. There will be two 40-million gallon pumps operating under a head of approximately 360 ft., and three low-service or raw-water pumps, two having a normal capacity of 50 million gallons in 24 hours and one a capacity of 100 million gallons when operating against an average head of 34 ft.

For the present, one traveling screen having a capacity of 100 million gallons at low-water elevation, will be installed. There will be two 250-kw. noncondensing turbine-driven generating units with the necessary switchboard, and the station will be served by three overhead cranes, one having a capacity of 30 tons with a span of 75 ft., another of 30 tons capacity with a 90-ft. span, and the third a five-ton crane with a span of 25 ft. The cranes will be operated by three-phase 440-volt alternating current. This, in brief, is the major equipment forming the initial installation of what eventually will be the leading pumping station for the city.

Westinghouse to Supply Big Waterwheel Generators

The Southern California Edison Co. has placed with the Westinghouse Electric & Manufacturing Co. orders for what is stated will be the largest horizontal waterwheel generators ever built, consisting of two 45,000 kva. units. These generators set a record for size, the next largest ordered being for 33,000 kva. capacity and another for 28,000 kva.

The two 45,000 kva. horizontal waterwheel generators will be totally inclosed and will have direct connected exciters and the usual accessories. Their total weight will be about 600,000 lb. each, the overall width and height being respectively 25 ft. and 23 ft. The length of the generator itself will be about 14 feet.

To Study Columbia Water Power Possibilities

An organization meeting of the Columbia River Commission was held in Spokane, July 12. Dr. Elwood Mead, commissioner of Reclamation, was elected chairman. Dr. Mead represents the Secretary of the Interior on the board.

An act of Congress passed at the recent session provides that the Secretary of the Interior may co-operate with the states of Washington, Idaho, Oregon and Montana, in the allocation of the waters of the Columbia river.

One of the purposes of the study is to determine the amount of water supply necessary for the Columbia basin irrigation project. The Board will undertake economic and other investigations, including the power possibilities of the stream. Another object is to report on the type of district organization best suited to handle the reclamation project.

Electrification in Sight for Northern Ireland

The commission appointed by the government of Northern Ireland to investigate the possibilities of electrical development recently submitted a report in which it advocated the development of electrical supply in that part of Ireland, according to advices to the Department of Commerce from Vice-Consul Russell M. Brooks, Belfast, Ireland.

The report stated that the most suitable centers to be included in any initial development scheme were Lisburn, Portadown, Armagh, Dungannon, Magherafelt, Ballymera, Antrim and Belfast. The subject of railway electrification was discussed but found to be undesirable at the present time. Additional powers were recommended for the Electricity Commissioners, and the appointment of a public board to supervise construction was suggested.

North Dakota to Get Two More Power Plants

More than $1,000,000 is being spent in North Dakota this year in the contruction of electric power lines and plants, an estimate by the state railroad board shows.

The Otter Tail Power Co., which has been expanding its holdings at a rapid rate, leads the field with a 2,000 kw. power plant to be erected at Washburn and 270 miles of distribution lines. Water for condensing purposes will be taken from the Missouri River, and lignite coal for the boilers will be obtained from near-by mines.

The Hughes Co. also is constructing a modern power station at Beulah, which will obtain coal from near-by mines. Both the Otter Tail and Hughes power plants will supply current to huge webs of power lines which rapidly are being extended by the respective companies.

Ontario Power Report Claims Fat Year

One of the most successful years in the history of the Ontario Hydro-Electric Commission is reported for last year in the annual report just issued. Distributing a load of 867,443 hp. and receiving a revenue of $18,002,148 from its municipal and other customers, the commission has been able to meet all its expenses, and has transferred the sum of $3,716,883 to a renewal sinking fund, and then achieved a clear surplus of $437,848. The total investment in the hydro-electric undertaking is given as $276,720,073.

Permits for Cumberland Projects Sought

Robert S. Gordon, of Louisville, Ky., has applied to the Federal Power Commission for a preliminary permit covering the proposed development of power at Lock No. 9 and Lock No. 12 on the Cumberland River in Jackson and Clay Counties, Tenn. As these dams flood out at times, the projects have no primary power. It is proposed to install equipment sufficient to develop 10,000 kw. at each site. Eventually this is to be increased to 13,000 kw. These plants are to be interconnected with those of the Kentucky Hydro-Electric Co.

New Jersey Unit Opened by Western Electric

A group of six-story buildings, forming another unit of the Kearny works of the Western Electric Co. on its sixty-acre tract in Central Avenue off Lincoln Highway, Kearny, New Jersey, went into operation June 24. R. C. Dodd, works manager, turned on the power which started a battery of several hundred cable-winding machines in operation on the lower floors.

The company plans ultimately to make the Kearny works a replica of its Hawthorne works near Chicago, which is said to be the largest in the world.

Central Stations Show Big Coal Saving

Greater efficiency in the central stations of the electrical industry has resulted in a reduction of coal consumption from 3.2 lb. in 1919 to 2.1 lb. per kw.-hr. in 1925, a decrease of 34 per cent in the amount of coal used per unit of power generated.

Obituary

Oberlin Smith, formerly president of the American Society of Mechanical Engineers and known throughout this country and Europe as an inventor and machinery manufacturer, died early July 19 at his home, Lochwold, near Bridgeton, N. J., in the eighty-sixth year of his age. He was stricken with heart trouble July 15. One of the most prolific and versatile inventors of his generation in the mechanical field, Oberlin Smith, at the age of twenty-three, established a machine shop at

Bridgeton, which in 1877 he enlarged into the Ferracute Machine Co. Of this corporation he was president and mechanical director for the remainder of his life.

He produced a great variety of machines, including his own numerous inventions, making a specialty of presses and dies for working metals. Of such machines he designed and manufactured more than five hundred different types for as any different uses, many of them being for the United States government and others for the Ford automobile works.

He obtained on his own inventions more than fifty patents, eight of them being for cutting, punching, drawing and coining presses, three for drilling machines, ten for looms, two for soldering machines, two for aërating devices and others for dump carts, pill compressors, keyless locks, wire gages, drink mixers, egg boilers, spring cotters, speed indicators and other contrivances. He also filed a caveat on a magneto-electric phonograph in 1883, but was debarred from obtaining a patent by the publicity which he had given to his invention.

The funeral services, held July 21, conducted in the Smith home in Bridgeton, were brief. The Rev. A. B. Collins, of the First Presbyterian Church of Bridgeton, officiated. He spoke briefly of the accomplishment of Oberlin Smith and said his name and works would never fade.

The American Society of Mechanical Engineers was represented at the services by two past presidents, Fred J. Miller and Morris L. Cooke, both of New York. Three members of the society, Henry A. Janvier, Wilbur E. Smith and A. C. McCutcheon, all of Bridgeton, were in attendance at the funeral. Burial was in Broad Street Cemetery.

Personal Mention

Edward D. Bottsford has terminated his association with Cass Gilbert, Inc., New York City, as designer of mechanical equipment and has entered a new field as executive in charge of the promotion of heat-utilization devices for the Interstate Corporation, Passaic, N. J.

Charles J. Murray has recently resigned from staff of The Linde Air Products Co., to become associated with the Oklahoma Contracting Co. He is now organizing a new division of that concern to engage exclusively in oxwelded pipe-line construction. During his association with the Linde Air Products Co., Mr. Murray specialized in this class of work and has studied the construction problems connected with a large number of notable trunk line projects.

Business Notes

The Beaver-Portland Cement Co. won in a competitive bidding contest for the purchase of the municipal electric plant at Gold Hill, Ore. This company offered $22,600 for the plant with an option to buy in five years.

D. E. Braine resigned as president of the K-B. Pulverizer Co. of New York City, July 10.

The Triple E Co., is a new incorporation in Aberdeen, Wash., capitalized for $30,000 with the following officers: P. A. Bertrand, president; S. P. Phillips, vice-president, and Frank Thomas, secretary-treasurer. The new concern will engage in electrical engineering projects, and their plans include an expansion program as business justifies.

The William Hamilton, Ltd., of Peterboro, Ont., manufacturers of pulp mill machinery and hydraulic power plant equipment, have been awarded a contract for the first new grinder unit for the Spanish River Pulp & Paper Mills at Marie, Ont., consisting of five 27-in. type "S" Leffel turbines, developing 1,200 hp. under 16 ft. head. The contract is reported to be the largest one for wheels ever let in Canada.

Coming Conventions

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates: **New York State Association.** Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J. **Wisconsin State Association.** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Trade Catalogs

Steam Purification — Andrews-Bradshaw Co., Pittsburgh, Pa. This is a 48-page illustrated catalog on the Tracyfier, Tracy Steam Purifier and Tracyfier Gas and Vapor Scrubber. It covers the necessity for cleaning steam and the benefits to be derived from the use of steam that is entirely free from boiler water or dust. The construction of the Tracyfier is clearly shown and its principles of operation are carefully outlined. The catalog includes a discussion of the effect of boiler water treatment and blow-down on steam quality. A section describes the application of the Tracyfier Gas and Vapor Scrubber.

Rotary Dryers—Ruggles-Coles Division, Hardinge Co., Inc., York, Pa. Catalog 16A recently issued describes and illustrates the various types of Ruggles-Coles Rotary Dryers designed to dry coal and other materials.

De Laval Pumps for Cleveland is a new publication booklet issued by the De Laval Steam Turbine Co., of Trenton, N. J. This is a study of the heat balance involved in the selection of prime movers for driving the pumps at Fairmount Pumping Station, Cleveland.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	July 19 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.63
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.60@ 1.90
Pittsburgh gas slack	Pittsburgh	1.20@ 1.30
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.30@ 1.65
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.50@ 3.50
Buckwheat No. 1.	Philadelphia	1.85@ 2.75
Birdseye	New York	.75@ 2.00

FUEL OIL

New York—July 22, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—July 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.00 per bbl.; 28@30 deg., $2.05 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5.8c. per gal.; 38@40 deg., 6.5 per gal.

Pittsburgh—July 19, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—July 17, f.o.b. local refinery 26@30 deg., $1.75 per bbl.

Philadelphia—July 8, 27@30 deg., $2.62½@$2.68½ per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.70@$1.76 per bbl.

Cincinnati—July 20, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—July 12, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.20 per bbl.; 26@30 deg., $1.30; 30@32 deg., $1.40.

Boston—July 19, tank-car lots, f.o.b. 12@14 deg. Baumé 4½c. per gal.; 28@32 deg., 5.9c. per gal.

New Plant Construction

Calif., Fresno — Yosemite Portland Cement Co., I. P. Mason, Purch. Agt., Pacific Southwest Bldg., plans to purchase equipment for cement plant to include two centrifugal slurry pumps 200 bbl. cement per hr. each, one centrifugal slurry pump 200 bbl. per hr., two 500 ft. and three 350 ft. 2 stage air compressors, etc.

Calif., Los Angeles—City plans $14,000,000 program for electric power to include the construction of a 4,700 hp. hydro-electric development and a new reservoir on Owens River. E. F. Scattergood, 1415 Berkshire St., is engineer.

Calif., Ocean Park—J. W. Stiles, c/o C. H. Russell, Story Bldg., Los Angeles, is having plans prepared for the construction of a 3 story apartment and stores building including refrigeration system on Main St. Estimated cost, $150,000. C. H. Russell, Story Bldg., Los Angeles, is architect.

Calif., Woodland—Reclamation Dist. No. 2068, will receive bids about Aug. 12 for improvements to waterworks, including 4 pumping plants, pumps, motors, etc. F. C. Hermann, Merchants Exchange Bldg., San Francisco, is consulting engineer.

Del., Wilmington—Diamond Ice & Coal Co. will soon award contract for the construction of a cold storage plant and warehouse. B. Gundloch, 110 E. 42nd St., New York, N. Y., is architect. Ophuls & Hall, Inc., 112 W. 42nd St., New York, N. Y., is engineer.

Ill., Chicago—Lake View Ave. Building Corp., S. E. Mittleman, Pres., 11 South La Salle St., awarded contract for the construction of an 18 story apartment at 2432 Lake View Ave. to Avery Brundage Co., 110 South Dearborn St. Estimated cost $1,250,000.

Ill., Chicago—Syndicate, c/o Oman & Lilienthal, 64 West Randolph St., Archts., will soon receive bids for the construction of a 17 story apartment including vacuum heating system, electrical refrigeration, oil burners, incinerators, etc. at 2132 Lincoln Park W. Estimated cost $1,300,000.

Ill., Hillside—City will soon award contract for improvements to waterworks, including deep well, pumping equipment, steel tank on tower, etc.

Ill., Markham—Village, will soon receive bids for the construction of a pump house, storage reservoir, 300 ft. well, pumps, etc. Barker, Flavin, Sheets & Wallace, 190 N. La Salle St., Chicago, are engineers.

Ill., Olney—City will soon receive bids for the construction of a waterworks and distribution system, including pumping equipment, mains, etc. Edward Flad & Co., 920 Chemical Bldg., St. Louis, Mo., are engineers.

Ind., Gary—Gary Hotel Building Co., is having plans prepared for the construction of a 9 story hotel at 6th St. and Broadway. Estimated cost $2,000,000. C. W. Nicol, 310 S. Michigan Ave., Chicago, Ill., is architect. Holden Bros., Chicago, Ill., are lessees.

Ind., Indianapolis—Indiana School for Blind, 75th and College St., will receive bids until July 30 for the construction of a power plant, laundry, etc. Estimated cost $100,000. Harrison & Turnock, 500 Bd. of Trade Bldg., are engineers.

Ia., Council Bluffs—City is in the market for new pumping plant equipment. A. L. Mullergren, 75 Bd. of Trade Bldg., Kansas City, Mo., is engineer.

Ky., Benton—City is having preliminary plans prepared for the construction of a waterworks system, including deep well pumps, etc. Estimated cost $35,000. F. B. Resses, Murray, is engineer.

Ky., Louisville—Louisville Water Co., 135 South 3rd St., plans the installation of a 40,000,000 gal. turbo-centrifugal pump in Crescent Hill pumping station. Estimated cost $175,000. Alvord, Burdick & Howson, 6 South Dearborn St., Chicago, Ill., are engineers.

Md., Baltimore—Bd. of Awards, will receive bids until Aug. 4 for the superstructure of a 3 story college, including power house at 33rd and Alameda Blvd. Estimated cost $1,700,000. Buckler & Fenhagen, 325 N. Charles St., are architects. H. Massart, 328 N. Charles St., is engineer.

Md., Baltimore—Civic Centre Realty Co., c/o L. R. White, Hearst Tower, Archt., awarded contract for the construction of an 18 story office building at Calvert and Lexington Sts. to Wells Construction Co., 237 5th Ave., New York, N. Y., and Vogswell-Koether Co., 406 Park Ave., Baltimore, Md., associate contractors. Estimated cost $1,700,000.

Mass., Beverly—Beverly Gas & Electric Co., 223 Cabot St., awarded contract for the construction of extension to water gas plant to P. J. MacNaughton Co., 755 Boylston St., Boston. Estimated cost $40,000.

Mass., Lynn—Sewerage Dept., will readvertise for bids for the construction of a pumping station. M. Knowles, 507 Westinghouse Bldg., Pittsburgh, Pa., is engineer. Former bids rejected.

Mich., Lansing—City opened bids July 9 for the construction of addition to Moores Park power plant, lowest bidder Davis & McGonigle, 1210 Buhl Bldg., Detroit, Mich. Cost $214,500.

Miss., Jackson—J. A. Teat, is having preliminary plans prepared for the construction of a hotel on President St. Estimated cost $1,000,000. N. W. Overstreet, Overstreet Bldg., is architect.

Miss., Picayune—City plans an election soon to vote $225,000 bonds for improvements to waterworks, including sewage disposal plant, pump house, pumping equipment, tank on tower, etc. Estimated cost $225,000.

Miss., Webb—City will soon award contract for the construction of a new waterworks system, including deep well pump, etc. Estimated cost $22,000. H. A. Mentz, Hammond, La., is engineer.

Mo., Kansas City—D. A. Schutte Cigar Corp., is having plans prepared for the construction of a 16 story office building at 10th and Main Sts. Estimated cost $1,100,000. F. E. McIlvain, 1001 Orea-Leslie Bldg., is architect.

Neb., Holdrege—City plans improvements to sewage disposal plant, including pumping station, sprinkling system., etc. Black & Veatch, 709 Mutual Bldg., Kansas City, Mo., are engineers.

N. Y., Brooklyn—S. Guardino, 8222 19th Ave., is having plans prepared for the construction of a 6 story apartment at 84th St. and 20th Ave. Estimated cost $800,000. DePace & Juster, 110 West 40th St., New York, are architects.

N. Y., New York—Brodsky & Klask, Inc., c/o Springsteen & Goldhammer, 32 Union Sq., Archts., is having plans prepared for the construction of a 5 story apartment at 187th and Elm Sts. Estimated cost $500,000.

N. Y., New York—B. W. Levitan, 100 East 42nd St., Archt., is preparing plans for the construction of a 10 story loft building at 127 West 125th St. Estimated cost $500,000. Owner's name withheld.

N. Y., New York—Malpac Holding Co., c/o G. G. Miller, 1482 Broadway Archt., is having plans prepared for the construction of an office building on Arthur Ave. Estimated cost $1,000,000.

O., Mt. Sterling—Waterworks Dept., plans remodeling pumping station, installation of a 100,000 gal. tank on tower, etc. Estimated cost $17,000. Jennings-Lawrence Co., Hartman Bldg., Columbus, are engineers.

Okla., Butler—City is having preliminary plans prepared for improvements to waterworks, including deep well pump, mains, etc. Estimated cost $18,000. J. D. Boinford, Elk City, is engineer.

Okla., Kingfisher—City, J. L. Williams, Supt., is in the market for a 750-kw. steam-driven turbine.

Pa., Allentown—A. Petruch and A. Gomery, awarded contract for the construction of a 10 story hotel at Hamilton and 6th Sts. to Roberts & Roller, 1700 Walnut St. Estimated cost $1,250,000.

Pa., Philadelphia—Baltimore & Ohio R. R., Baltimore, Md., awarded contract for the construction of a cold storage plant and warehouse including switch house, transformers, etc. here to Hughes-Foulkrod Co., Commonwealth Bldg.

Pa., Philadelphia—Dept. of Public Works, Bureau of Water, will receive bids until August 3 for furnishing and installing electrical equipment, switchboards, electric pump and auxiliary equipment in Torresdale pumping station.

S. D. Agar—City will receive bids until August 5 for the construction of a waterworks system, including pumping plant, 25,000 gal. tank on 100 ft. tower. Dakota Engineering Co., Mitchell, is engineer.

Tenn., Selmer—Southern Cities Power Co., Provident Life Bldg., Chattanooga, has acquired a site and plans the construction of a generating plant on Front St. here.

Texas—Magnolia Petroleum Co., Fannin and McKinney Sts., Houston, plans the construction of an oil pipe line, 80 miles long from Luling to Miranda including pumping stations at 60 mile intervals. Work will be done by owner's forces. Estimated cost approximately $6,500,000. Private plans.

Tex., Alice—Texas Central Power Co., Frost Bldg., San Antonio, plans extensions to light, water and ice plants here. Estimated cost $75,000. Private plans.

Tex., Amarillo—Kansas City Power Securities Co., subsidiary of United Power & Light Co., 14th St. and Grand Ave., Kansas City, Mo., plans the construction of a 10,000 kw. electric power plant near here. Estimated cost $1,250,000. Private plans.

Tex., Edinburg—Valley Electric & Ice Co., has work under way on the construction of an ice plant. Estimated cost $45,600. Private plans.

Tex., Galveston—Galveston Electric Co., 21st St. and Ave. I, plans to rehabilitate present machinery and install new machinery in electric power plant. Estimated cost $184,000. R. E. Tabor, c/o owner, is engineer.

Tex., Muleshoe—City is receiving bids for improvements to waterworks including pumping station, 250 g.p.m. centrifugal pump, 50,000 gal. tank, etc. Estimated cost $40,000. Montgomery & Ward, 545 Harvey-Snider Bldg., Wichita Falls, are engineers.

Tex., Rochester—City is receiving bids for waterworks improvements, including a well, pumps, motors, tank on tower, etc. Estimated cost $75,000. Utilities Engineering Co., Wichita Falls, is engineer.

Tex., Stanton—Hawley & Roberts, Cotton Exchange Bldg., Ft. Worth, Engrs., will receive bids until August 2 for improvements to waterworks, including 3 water wells, gasoline engines, well houses, three 10,000 gal. storage reservoirs, etc., for Martin Valley View Water Control & Improvement Dist.

Tex., Val Verde—Val Verde Industries, c/o H. P. Hansen, Pres., awarded contract for the construction of a refrigeration plant to T. T. Hopper, Post-Dispatch Bldg., Houston. Estimated cost $150,000.

Wis., Hiles—C. W. Fish Lumber Co., Elcho, plans to rebuild saw mill and boiler house recently destroyed by fire. Estimated cost $80,000.

Wis., Marshfield—Water & Light Dept., G. Marvin, Secy., will receive bids until July 30 for a 1500-kw. high pressure condensing system turbine unit.

Ont., Preston—Werlich Furniture Co., plans extensions to factory, including boiler room, etc. Additional equipment will be required. Estimated cost $50,000.

Ont., Windsor—Ontario Hydro Electric Ry Comn., 190 University Ave., Toronto, plans the construction of an electric converter station at Erie and McDougall Aves. here to supplement the electric power supply to Windsor and Border car lines. Estimated cost $150,000. F. A. Gaby, 190 University Ave., Toronto, is chief engineer.

Alaska, Fairbanks—General Electric Co., Coleman Bldg., awarded contract for complete power plant equipment consisting of 10,000 kw. steam turbine, transformers, transmission line materials for 25 mi., 32 v. distribution system to Fairbanks Exploration Co., Fairbanks, Alaska. Estimated cost approximately $200,000.